# A STUDENTS' MANUAL OF EXPERIMENTS IN PSYCHOLOGY

## QUALITATIVE AND QUANTITATIVE

S. JALOTA

THIS BOOK is intended to serve as a 'laboratory guide' as well as a 'manual of applied psychological statistics'. It provides adequate assistance for practical assignments to students undergoing a course in experimental psychology at the university level. It makes up for the deficiency of training in introspection — a shortcoming to be found in many existing textbooks on the subject. A series of *qualitative* experiments have been collected and so arranged as to provide an introspection-oriented course as well as training in elementary statistics to beginners in experimental psychology. Other experiments dealing with the procedures for comparative studies provide more advanced training.

Experiments in the *quantitative* section cover the course in psychophysics and psychometry. Here the material is arranged according to complexity of statistical technique employed. Application of formulae is illustrated with the help of local data. Variations in procedure and formulae are also given.

In keeping with the growing emphasis placed on the use and interpretation of psychological tests in Indian Universities, Professor Jalota refers, in the section dealing with psychometry, to *non-verbal performance tests* and to *verbal group tests* in Hindi. Procedures for test-standardization are illustrated by preparation of *norms* for individual tests, while the data on group tests are used for derivation of percentiles, Z-scores and T-scales.

Written by one who has the rich experience of well over a score of years in teaching at the university level, the book will prove to be of immense value both to students and teachers.

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# EXPERIMENTS IN PSYCHOLOGY

*Qualitative and Quantitative*

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To

MY MOTHER

# PREFACE

This book has been written to serve the dual purposes of a 'laboratory guide' as well as of a 'manual of applied psychological statistics.' The student will find here adequate assistance to meet the practical assignments for a course of experiments in psychology. Textbooks by modern European or American scholars usually neglect the aspect of training in introspection. I consider this training as important as that of other techniques employed in experimental psychology. So I have collected here 24 *qualitative* experiments and arranged them to provide a gradual training in introspection, as well as in elementary statistics. In each of this series there is a more or less direct emphasis on introspection. Most of these experiments can be performed without any recourse to elaborate apparatuses or equipment. This provides an introspection-oriented course for beginners in psychology. I have also suggested in several experiments the procedure for comparative studies, which constitutes the essence of a relatively advanced level of training.

In the following *quantitative* section there are 25 experiments meant to cover the course in *psychophysics* and psychometry. Here, the order is according to the complexity of the statistical techniques employed in the given experiments. The initial application of formulae are illustrated from local data. Often, the variations of procedure, or the peculiarities of a given set of data require the use of suitable variations of the formulae. I have given a good number of them which are known to be sometimes favoured in other laboratories of psychology in India. Hence I hope this manual will also be found useful by the students in the various Indian Universities.

In most Indian universities there is a growing emphasis these days upon the use and interpretation of psychological tests. In the portion of this manual dealing with *psychometry*, I have referred to well-known *non-verbal* performance tests as well as to *verbal group tests* in Hindi. Some of the latter are available in the form of *reusable* booklets with separate answer-sheets, and others in the form of *consumable* booklets. Whatever the form available in a given laboratory, in each case the manual of directions for the specific tests is to be followed. However, the given techniques apply in both the cases. I have illustrated the procedures of *test standardisation* through the preparation of *norms* for individual tests, and used the group test data for the derivation of *percentiles, Z-scores* and T-scales.

I acknowledge special indebtedness to the writings of Prof. R. S. Woodworth and of Prof. J. P. Guilford. I express my sincere gratitude to all those ex-students whose experimental data has been used in this manual; their names are individually mentioned along with their data.

In this edition a serious attempt has been made to eliminate errors and misprints, and to expand clarifications of the text wherever indicated through its use in the different classes for the last six years. I shall feel amply satisfied if the students and teachers of experimental psychology in India find this *student's manual* helpful in their practical assignments.

SHYAM SWAROOP JALOTA

*Chandigarh*
11*th November* 1962

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# INTRODUCTORY

# I

# INTRODUCTION

A *science* is an orderly and systematized account of *facts*. The facts are obtained by *observation*. Usually these facts are natural events or occurrences. Often we find that certain facts are related together according to a definite principle. The discovery of such laws enables us to understand the said occurrences or events in the given field of science. For instance, the changes of the seasons in a regular cyclic order are facts of observation. Their special sequence can be understood by a reference to the diurnal rotation of the Earth, the inclination of its axis, and its orbit round the Sun. Thus, each science observes facts in a given field of nature, and also tries to discover the principles of their relationships.

The observation of facts requires the use of *sense-organs*. A clear perception requires adequate *attention*. Sometimes we take the help of suitable *instruments* to observe and measure our facts. All these measures of facts are recorded. *Recording* implies the use of *memory*, *language* and the use of *writing* and *numerical symbols*. Many times we do not observe the facts directly, but we observe other events and changes believed to be directly related with the given facts, *e.g.* we directly observe the mercury column of a thermometer, and believe that we are observing the heat of a given body.

All our observations are *selective* in character. We observe at a time, only one of the several aspects of the natural phenomena before us. We measure the height of an object at one time, and we measure its weight, etc. at another time. For a fuller understanding of the qualities, activities and relations of the objects and events being observed by us, it is often necessary to *vary* the conditions of our observations. And such a variation implies some measure of control over the conditions. Further, *an observation under controlled conditions* becomes an *experimental observation*. When we vary conditions within our control, we usually do so because of a definite *purpose*, *e.g.* in an experiment on memorizing, we can vary the task to be learnt — 'a hundred words of *prose*' to an equal number of words in a *verse*. Such a variation indicates the purpose to enquire into the efficiency of memorizing the passages of prose *as compared* with equally long passages of verse. Thus, the purpose of the experimenter determines the character of the variations. Hence, comparison of the pre-variation with the post-variation facts and figures should satisfy the said enquiry by the experimenter. In other words, each experiment reveals the nature of an enquiry. So it is said that 'an experiment is a question put to nature'. Hence, it is essential for an experimenter to *know* what he is going to enquire in the course of a particular experiment.

We often find that an experimenter *E* is aware of some law or hypothesis ; and he wishes to perform an experiment to verify the given law or hypothesis. He knows that 'a sensation of pressure' from lifting a weight of 100 gm. will not be readily distinguished from a weight very slightly different, *e.g.* 100.1 gm. But it will be distinguishable half the times from a 'just noticeably different' weight. So the question : What is the *upper* difference limen for a given subject ? Now he can devise an experiment, that is prepare conditions for observation, and vary them in a desired manner, *i.e.* obtain comparisons of a *standard* 100 gm. weight with weights of 104, 108, 112, etc. gm.

For the sake of simplicity an experiment is so arranged that only *one variable* is altered in the course of an experiment. All *other conditions* of the experiment are to be *held constant* from one observation to another. This can be easily done in the case of physical experiments. The size, weight and composition of the objects to be observed can be kept constant. But in the case of observations with living beings, whether plants or animals, it is not easy to keep all other conditions constant. Living beings are influenced by time, they grow and develop. Though in theory at no two moments is a given animal the same ; yet for all practical purposes, we may *assume* that there is *no noticeable difference* between the conditions of the animal at any two given moments (specially when they are near enough in time). Some such assumption is implied also in the series of observations with the subject of a psychological experiment. We perform an experiment and take a few hundred readings or observations on one day, and we take another series of readings or observations on another day. And if the general conditions of the given experiment are under control, we assume that the Observer's general condition has continued to be constant during the periods of our observation. But such assumptions are precarious. Thus while in Physics the variation of *one* condition only *proves* the existence of a causal relation (or 'a probable part of a causal relation'); in the biological and social sciences, one experiment can only *suggest* the possibility of a definite relation. Repetitions *strengthen* the suggestion and also indicate the probable bias of the given experiment by giving the extent of *errors* (variable or constant, etc.). Hence, the validation of our assumptions forms an important part of the psychological experiments.

The methods for the variation of given conditions give rise to different *designs* of the experiments. The manner of each controlled variation leads to the discovery of peculiarities of data ; and it often needs a special type of statistical treatment. It follows that some experimental methods are more appropriate and fruitful in certain fields than in others. Further, in psychological experiments, we usually have an Observer (*O*), [or a Subject (*S*)].[1] Certain stimuli or situations are presented to the *O*, and his responses are observed and recorded. Sometimes the response is in the form of a spoken word (or a phrase), *e.g.* "Of the given pair of colours, which is preferred ?" The response may be "Red", or the "right hand one", etc. These word-responses of the *O* are taken to indicate appropriate mental processes. Thus they are assumed also to represent the *introspection* of the given *O*. In the course of certain experiments this method is employed to discover the *impressions* of the stimuli upon *O*. So such experiments are broadly classified under *methods of impression*. In a different type of experiment, the bodily responses of *O* are recorded, *e.g.* variations in respiration due to attention to a problem-solving task. The pneumographic record of the respiration curve for a given *O* is first obtained in the condition of 'passive attention', and later in the condition of 'active attention' to the given task. In such a case we are concerned with the varying expressions of the body going on simultaneously with the mental processes. So these experiments are put under the broad category of the *methods of expression*.

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[1] The term *subject* has some philosophic implications. The letter *S* will be used for the Stimulus. Hence, the letter *O* will represent the Organism or the Observer in this book.

## II

## INTROSPECTION

A student of psychology is expected to study *mental facts*. These facts can be directly known only through *introspection*, which means 'looking inwards'. This sort of *looking inwards* in practice is an attitude of attending to, receiving the impressions of a given stimulus or situation, and of recalling as well as reporting them in a suitable language. The term *introspection* was restricted by the early experimental psychologists like Wundt, Titchener, etc. to the observation of the *elementary* experiences, i.e. *sensations*, *images* and *feelings*. They objected to simple commonsense statements like, "I heard the word *ready*". They said that *O*'s experience has no "I" - reference ; but there is only the auditory experience of "ready" ; some images, visual-verbal, or kinaesthetic, etc. So the popular expression, "I heard", was considered as "commentary biassed by a pre-analytic and unscientific usage". This is also called *stimulus*-error, as there is a reference to the stimulus.

They were of the opinion, that with sufficient alertness and practice, one may even locate the sound impressions in the outer ear, or the inner ear. The newcomer to the Laboratory of Psychology was expected to practice introspection, by closing his eyes and giving a report of his visual experience, as a field with a variety of colours in vague outlines, which shifted from moment to moment. In other cases, the observer was asked to close his eyes and imagine the chair on which he was sitting. He was expected to indicate the colour, shape, direction, size, location, etc. of the chair-image. The repetition of such exercises, say 50 times, can greatly improve the capacity for introspection. In the absence of such a prolonged practice, and the inability to avoid use of biassed reference-terms, like "I", etc., it would be more appropriate to describe the remarks by any Observer as a series of introspective *comments*.

In an experimental setting, or a more or less controlled laboratory situation, we try to improve the efficiency of the Observer by providing suitable conditions for attention, reception and recall. Some of these conditions are *negative* in character ; they are for removing distractions, etc.; while other conditions are *positive* and help the reception of the impressions, as well as increase the chances of accurate recall, *e.g.* in an experiment for the exploration of the touch-spots, we ask the *Observer* (or *O*) to 'close his eyes'; thus we try to eliminate the visual distractions from his experience. We give him the signal 'ready' to permit him to attend to the area of the skin marked for exploration. Thus he will get a better chance to receive the impressions of the stimulus. We also ask him to immediately report his experience; and in this way too we try to reduce the chance of memory-lapse or forgetfulness. In other experiments, we often ask the *O* to report specially on the character of his imagery and nature of associated ideas, etc.

The experiences of perception are essentially *private*, being the direct experiences of one individual. He alone has direct knowledge, and he is the only person who can report upon them. In the 'laboratory of psychology' it is assumed that the Observer (or Subject) in an experiment is willing and ready to tell as much as he can. Further, if we help him in his introspective effort, by repeating the given experiences in as constant a manner as possible, we can enable him to note and to give clearer as well as fuller reports of his experiences. However, all this needs adequate training in observation and reporting. The technique of reporting can be considerably improved by looking for specific aspects, changes and relations, as well as by the careful selection of adequate technical terms. The former is a part of experimental technique, and the latter is a matter of theoretical understanding and knowledge. We shall thus be mostly concerned with the former aspect.

In each case of a psychological experiment, we observe some behaviour, *e.g.* verbal comments; or the form of the respiratory curve. In short, the experimental method in psychology is always a case of the study of behaviour. (This is known as *methodological behaviourism.*) It may be added that in each case this behavioural activity is assumed to represent some specific mental activity, *e.g.* the preference for a colour; or the state of attention. However, with human observers, in both the cases we could also ask for more detail in the nature of *O*'s introspective comments, *e.g.* "This red reminds me of a very pleasant experience some months ago"; "In solving the given problem, I experienced a tendency to use words, I felt some pressures in the lips, kinaesthesis from the eyelids, etc."

It is to be noted that a considerable portion of psychological knowledge is obtained through the interpretation of external behaviour. We take records of speech, postures and movements, and try to read the mental experiences conveyed by them. Indeed the method of 'studying behaviour' is the only possible method for knowing or estimating the experiences and attitudes of another. It is interesting to note that when Arjuna wants to know about the *sthitaprajña*, he asks, "how does he speak, sit and walk ?" (kim prabhāṣeta kim āsīta vrajeta kim. *The Bhagwadgītā*, II, 54). However, the observation of behaviour has to be interpreted on the analogy of one's own experience. When the *O* indicates preference for a given 'red' as compared with a given 'blue', the experimenter can understand that to mean some mental processes only in the light of his own experiences in a similar situation of preference. Here too it is interesting to find that Arjuna is also told elsewhere, "the person of disciplined intellect sees all uniformly on the analogy of his own pleasant or unpleasant experiences" (ātmaupamyena sarvatra samam paśyati yo 'rjuna sukham va yadi va duḥkham sa yogi paramo mataḥ. *Ibid*, VI, 32). But in all such interpretations of "direct mental experiences" there is always a risk of error, as much due to *E*'s prejudice and misplaced sympathy as due to his lack of adequate experience. When *A* has tasted a fresh, warm and succulent (or juicy) *jalebi*, he can more accurately appreciate the reported experience of *B*'s taste of the said sweetmeat. But if he has never tasted a chocolate-cake, he cannot have any adequate knowledge of *D*'s reported experience of the said taste. We have to note these limitations of the methods of introspections, as well as of the interpretations of behaviour, and to be duly careful in giving a value to our observations and in drawing any conclusions from them.

## III

## TASKS OF THE EXPERIMENTER AND OBSERVER

A psychological experiment involves the cooperative effort of two persons: An Experimenter, or $E$, and an Observer or $O$. (We want to use the symbol $S$ for a stimulus, hence we will not refer to the person subjected to the conditions of a psychological experiment as the Subject or $S$.) In a class experiment usually two fellow-students join together to carry out a given experiment: and the two play both the roles by simply interchanging their tasks as $E$ or $O$. Of the two partners of the experiment $A$ and $B$ if at first $A$ is the $E$, and $B$ is the $O$, then later on, $B$ becomes the $E$, and $A$ acts as the $O$. Thus both of them learn the peculiarities of both the aspects of a given experiment. This is indeed very essential for a proper appreciation of the total experiment.

In the course of any *experiment*, $E$ has to arrange the conditions of the laboratory setting, vary them according to a prearranged plan of procedure, and keep an accurate record of the *Observer's* reports as well as of his more or less specific behaviour. Although the "laboratory guide" helps the individual $E$ by pointing out what he has to do, yet there is much that is to be got ready by him, in consultation with the instructors, etc. to suit the equipment and other needs of the given laboratory. Sometimes all students are required to perform the same set of experiments. This is convenient for the laboratory administration no doubt, but it leads to stereotyping of reports, which hinder the growth of individual thinking.

*A*. The *task of E* is different from that of $O$ in the course of a given experiment. The $E$ has to *arrange the conditions* of the given experiment. These include, (*a*) the arrangement of the apparatus, etc. for *presentation of the stimuli*; (*b*) the arrangement of the apparatus, etc. for *recording the responses*; (*c*) the preparation of *instructions*. He also prepares (*d*) the *design* of the order of presentation of the variables; plans the *procedure* of the course of experiment, specially the periods for work and rest, as well as the occasions for observations and the introspections or $O$'s comments. He has also (*e*) to *arrange for the seating* of the Observer, as well as for his accommodation during the period of rest; (*f*) *requisition* the necessary apparatuses and materials; (*g*) *calculate* the data, tabulate the results, and *write a report* of the given experiment in his practical notebook.

In each experiment the *Observer* is expected to respond in a definite manner. His response indicates some aspect of his experience in the given situation. Hence, we *instruct* the subject to look for certain aspects in his experience, and to give his response in a specific way, *e.g.* in the case of choice reaction-time experiments, we instruct the Observer to "respond with the right hand to the *red* light, and to respond with the left hand to the *yellow* light." The response will indicate that he has noticed the given 'light' stimulus, and chosen to respond with the proper hand. Thus the time taken for these responses will tell us something about his speed of choice between the receiving of given simple stimuli and the sets of simple responses. But, if we also ask him to report upon the early, middle, or final phases of his experience, we will be able to get an introspective record of the fore-period, mid-period, or end-period of the given choice-situation. In this way we could combine the several reports and get a composite "picture of the 'mental' experience" during 'choice'. To sum up: It is necessary to prepare and give proper *instructions* to the Observer, and it is also proper to see that the given instructions are actually followed in the course of the said experiment. When the instructions are *not* followed in practice, it means that the general conditions of the experiment *do not* remain constant. Lack of constancy vitiates the 'controlled aspect' of the said experiment, and the value of such observations is wasted.

*B*. The *task of O* is relatively more simple. He is expected primarily (*a*) to *cooperate fully*; (*b*) he has to *attend* to the situation *according to the instructions* given by *E*, when signalled for the purpose; (*c*) give the responses while strictly adhering to *E*'s instructions; (*d*) accept the restrictions upon bodily movements, or sensitivity, *e.g.* by using the chin-rest, head-rest, blind goggles etc.; and (*e*) to give as detailed introspections or comments as he can.

When the experiment is long, and a large number of observations are to be taken, the *O* should be given adequate rest, or if he feels tired, etc. he should ask for a rest period. In other words, *E* should so foresee the situation, in which *O* and *E* can exchange their roles, when *O* needs rest.[1] This should be the rule, except when the peculiar conditions of the given experiment do not permit such a procedure. Usually such an exchange of roles is easily possible, and it should be carried out to avoid unnecessary wastage of laboratory-time; or the highly objectionable accumulation of data under widely varying conditions, *viz.* freshness and interest versus fatigue and boredom. Later, they will write their reports severally, and submit them for correction and signature to the laboratory authorities. In many cases the same pair of partners continue to work together throughout the session. However, this is not necessary. What is essential is that the two partners should carry on together in the course of *one* experiment and complete the observations. Later, they may work together or not as suits their convenience.

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[1] E. B. Titchener suggested that *E* and *O* change roles after each series of ten reaction-time readings. (*Students Manual*, Vol. I, Part I, 1901, p. 117 f.)

## IV

## REPORT OF THE EXPERIMENT

The *report* of the experiment usually includes the following: (1) Title of the experiment; (2) The Observer (or Subject); (3) Date and time; (4) Materials; (5) Procedure; (6) Results; and (7) Remarks.

1. *Title of the Experiment*: This is generally a problem which we try to solve. It is assumed that *E* knows what he is going to do, and the sort of data he is likely to gather in the course of a given experiment. So the title of the experiment should be given in the form of a *problem*: "To find out the general mental ability of *O*"; or "To determine the upper difference limen for lifted weights by *O*"; or "To study the laws of association, etc." In each case the problem is specified, or assumed to be limited to the given conditions of the experimental situation and the corresponding responses of the *O*; *e.g.* the measure of general mental ability is obtained by the use of a specific test, say the Group Test in Hindi (1–60); the *UDL* is found for a given standard weight, say of 50 gms.; the laws of association are to be studied as indicated by the free association responses of a given *O* to the given list.

Some persons like to include a reference to broad details of procedure, or of statistical techniques, or of both *e.g.* "To measure the time for association of ideas for *partial* and for *complete* constraint with a list of ten words each from *Lab. Guide* by Munn, and find out the *t* coefficient of the difference." This tends to give a title several lines in length, and it appears more like a cumbersome description rather than the title of a class experiment. We think it is much more simple and useful to modify the given title as "A study of constrained association times." Other conditions are more appropriate to the paragraphs about materials and procedure.

If the tradition of a laboratory requires that all the experiments in the syllabus on memorizing, or association, etc. should be done in a prescribed sequence; or that the reports be arranged in some other systematic order; a number of different experiments then become parts of a series; and the said experiments can be given very brief titles, *e.g.* Reaction Time : (*a*) Sensorial : Reaction Time ; (*b*) Muscular : Reaction Time ; (*c*) Choice ; etc.

2. *The Observer* : The *O* is usually described by *name* ; and frequently some other *relevant* particulars are recorded. There may be a reference to age, sex, and condition, etc. Only such particular conditions are relevant as are later to form the basis of certain remarks on the given results, or on the peculiar course of the given experiment. Otherwise the physical condition of *O* is assumed to be 'fresh and normal', or 'usual', unless he is specially fatigued, drugged, or hypnotized, etc.

3. *Date and Time* : This is quite an important item. In any college the morning or afternoon periods would mean a different degree of freshness and fatigue, etc. Again, it is useful to know if different sets of readings have been obtained on different days and times.

4. *Materials* : This includes all the apparatuses used. The *materials* are listed together, as, 'Kymograph, glazed paper, electric batteries, push key, commutator, electro-magnetic marker, connecting wires, time-marker, screen, reversible perspective figure, stop-clock,' etc. It is useful to list all the materials including screens, goggles, record-sheets, pencils, etc. The familiar materials are not described. But each apparatus should be briefly described, *e.g.* Stop-watch, unit 1/5th of a second ; Tachistoscope for long exposures ; screen, wooden (or cardboard); etc. It is not a common practice to mention also ordinary furniture and equipment, *e.g.* two stools, one table, a smoking burner, a smoking stand, varnish, tray, drying stand, etc. These are assumed to be available in each laboratory and not considered important enough for special mention in the report.

When several apparatuses are used together, it is useful to give a "ground plan" of the arrangement of the apparatuses. Only the position occupied, and the electrical connections, if any, are shown in the plan. If necessary, separate diagrams are drawn giving *side* and *front elevations* of any one apparatus, or of the parts of an apparatus. These are meant to show the details of its structure, specially the mechanical or electrical relations or peculiarities of the various parts. Usually such figures are not drawn to scale, nor are they given in the third dimension, as the average student of psychology is not expected to be an expert draughtsman.

To sum up, the various diagrams should indicate, (*i*) the plan or the arrangement of the apparatuses, including the seating of *E* and *O* ; (*ii*) the plan of the electrical connections ; and (*iii*) the *elevations*, both *front* and *side* for specific apparatuses. In a few cases, a *section* diagram, or the *back elevation* may also be necessary.

If necessary, each of the materials may be described in some detail, *e.g.* "Kymograph (C. F. Palmer): It is an apparatus for obtaining the moving record of responses". "Time-Marker — weighted spring type, adjustable to mark 1/5th and ½ seconds, etc." In each case, there should be a reference to its location in the plan, or to its figure when drawn in the note-book. When special record-sheets or answer-sheets are used, then these should be mentioned among the materials.

5. *Procedure* : The procedure is to be given in such detail as to enable any other person to *repeat* the same experiment and to verify the given conclusions. The procedure broadly includes, (*i*) the arrangement of the apparatus as well as its testing for working efficiency ; (*ii*) the procedure for seating the Observer and preparing him for responding in the specific experimental situation. This implies (*a*) the use of blind goggles, chin rests, etc. and (*b*) the directions regarding preliminary or final signals, and specific *instructions*. It is advisable for the *E* to write down the desired instructions and use them *verbatim*. Any change in the wording of the instructions during the different stages of the experiment should be carefully noted.[1]

It is only such a careful record that can determine how far any verbal changes are really significant or not. Further, if the Observer (or Subject) is not well versed in English, the necessary instructions should be given in the language well known to him. In some cases, the instructions have to be kept constantly exposed before the subject. The instructions are written in a legible hand and placed near the Observer, where he can readily see them from time to time. Of course, this is possible only in those experiments where the *O* keeps his eyes open.

The *instructions* are supposed to be the conditions that go to form the specific *task-attitude* of the Observer. It is also assumed that in the course of a long series of observations, the given instructions are assimilated by *O*, and continue to operate as *self-instruction* for the duration of the said experiment. It would be better however to display the written instructions somewhere on the screen facing the *O*, or near *O*'s response-key. Thus they will act as constant reminders to *O* and help him in maintaining a fairly constant attitude. This is especially necessary in the case of "reaction-time experiments", as it is very important to maintain the required 'sensorial', or the 'muscular' attitude, else *O* is likely to slip into the 'natural' reaction attitude.

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[1] In some complex situations the instructions are aimed at explaining the given task and so a definite verbal form is not strictly adhered to.

The *instructions* are largely determined by the purpose of *E*, the apparatus employed, and the general traditions of a given laboratory, *e.g.* the use of courtesy terms like 'please', 'kindly', 'request', etc. The use of warning or caution, "you will be required to comment upon the course of the experiment"; the information regarding procedure, "you will be given rest after 25 readings"; or "you will give one series of 20 judgments, and after 1 minute's rest you will have to give another series of 20 judgments", etc. There is no doubt that each of these variations will have a specific effect upon the task-attitude of the Observer. However, considering the specific traditions of a given laboratory, such variations may be considered as minor modifications of a constant character in the given laboratory attitude or atmosphere.

We know that in all experiments there is a *variable* condition. It may be a stimulus, or some aspect of the laboratory situation; *e.g.* a patch of colour, *or* the time for exposure, etc. The variable condition is changed from observation to observation according to a pre-arranged plan, or *system*, or *design* suited to the given investigation. In some experiments the given stimulus is definitely increased from a definitely sub-liminal position, or decreased from a definitely supra-liminal value. The *order of* these *variations* is to be planned beforehand; or it can be settled after a few practice observations. In each case the arrangement of the variations (or *variables*) followed in the course of the experiment is an essential part of the *procedure*. It must be given in adequate detail. When the same procedure is followed for several observations, then it is possible to describe the procedure in detail for a set of observations, and then mention the number of times the said procedure is repeated, *or* the sets of observations that are obtained.

The *procedure* of the given experiment may indicate, *either* very briefly the outline of the course of variations to be introduced in the experiment; *or* give in detail the given order of the variables presented to *O*, and the corresponding order of *O*'s responses. In the former case, the details are conveniently given and tabulated under the heading of *results*. Here, too, much depends upon the views of the authorities of a laboratory. One thing alone is definite, that an order of the presentation of the variable stimuli (or situations) should be definitely drawn up by *E*. This may be first prepared on a rough paper, and later a fair copy written in the practical note-book. But it would be preferable, if the tabulated order of the individual variables is prepared directly and neatly in the practical note-book itself.

In many experiments, it is necessary to give a period of *rest* to *O* after taking a series of observations. There should be a sufficient description of these intervals, as well as of the character of the occupation provided to the observer during the rest period, if any. Rest is usually provided firstly to avoid the possible effects of fatigue; and secondly to permit a necessary rearrangement of the apparatus, including the readjustment of the stimuli, or the filling in of record sheets, etc.

It is advisable to have a few *practice* observations. The practice experiment serves two purposes. Firstly, it points to *E* the weaknesses or errors of the procedure, if any, and thus enables him to improve his technique for the experiment proper. Secondly, it familiarizes *O* with the conditions of the given experiment, and thus improves the *rapport* with *E*. The order of variables for the practice experiments, should also be prepared in advance, if necessary, and the records of the practice responses must be shown separately. Sometimes, the practice experiment is also used for a preliminary rough exploration, *e.g.* during the determination of the *two-point threshold* by the method of serial exploration, the preliminary observations with 5mm. graded variables indicate the probable range for later careful exploration with variables differing by only 1 mm.

Further, it is often useful to draw up a *brief rough outline* of the *procedure* of the experiment and its various stages. This enables *E* to note the course of his progress; also it serves to clarify the method used as well as the purpose of the experiment. In general, any procedure follows the well-known stages of some method of psycho-physical observation. However, in each case some modification is possible as well as necessary, to suit the peculiar sensitivity of a given subject, e.g. the number and range of the variables ($V$), as well as the total number of observations necessary for a reasonably accurate measurement. Such modifications can be easily included in a rough outline of the procedure.

Just as the report is expected to give an account of the apparatus and materials used, it is also assumed that the said *apparatuses* are in optimum *working order*. So $E$ should see that the electrical connections are performing the expected tasks efficiently. The $O$ should be seated in a comfortable position. The response-key, if any, should be within comfortable reach. If the experiment is to continue for a long period, due care should be taken that the elbow of $O$ is not pained by contact with the hard surface of the table. In the case of a *tachistoscope*, the level should be so adjusted as to give comfortable vision to the Observer. Also, due care should be taken that $O$ is not disturbed by noises or voices, at least for the duration of the experiment proper. To maintain an undisturbed and constant attitude towards the given task, the *O should be seated facing a screen ;* and the observer should restrain the tendency to look away and be interested in (*i.e.* disturbed by) irrelevant objects or events.

Often the freshman $O$ is keenly interested in the results of his judgements. But in many experiments $E$ cannot tell him about his errors or successes. Such a procedure would convert the given design of the experiment into one of *learning procedure*. Many times even in *learning* experiments the results are not to be told to $O$. It is obvious that any remarks by $E$ would disturb and modify the natural course of progress in mirror-drawing experiments, and materially alter the form of the curve of learning. One general rule, from the point of view of rapport is, "never tell $O$, he is in error"; always give an encouraging "OK", "Good", etc., *unless* the specific nature of the given experiment requires otherwise.

In most experiments the various observations are grouped together, and the data is subjected to some statistical treatment. While this takes a considerable time and space, the aims of the said statistical procedure could be briefly summarised as, 'calculate the constant error'; or 'find out the various means, and the significance of differences, among the means if any', etc. The statistical treatment however will follow the tables of results, as it depends on the said data.

6. *Results*: These consist of the *raw data*, as well as of the *introspective comments*, if any. The record of the varying series of judgements as obtained in the actual course of the experiment are described as *raw results*. Usually these are arranged in simple tabular form and the data is arranged according to the serial order of the responses. The raw results are later analysed and put in separate tables to show in an abbreviated form some relevant aspect of the given data (*Tabulated Data*). Hundreds of observations can be thus summarised into a small table: Supposing there are 6 variables, judged 'lighter', or 'equal', or 'heavier', a hundred times each: a total of 600 judgements. Then after analysis all the said data can be put in a table with 4 columns and 6 rows. The given 6 variables are arranged in the rows in an ascending or a descending order. Each of the columns carries the total number of the different judgements given for each variable, after analysis of the data, e.g. columns for 'lighter', 'equal' and for 'heavier' judgements. At times the raw data is collected, as well as analysed and tabulated at the same time. This needs a little planning and practice, and should be attempted whenever possible by *E*, by preparing suitable record-sheets. Sometimes the results are also presented in the form of a *comparative table*. This enables the reader (and *E*) to compare observations under different conditions, or for different groups or classes of subjects, e.g. "Standard Right" and "Standard Left"; or results for boys and for girls. However, the experimenter is to be cautioned against trying to compare several varying classifications of the data in a single table, as they are more likely to confuse the reader than to clarify the presented results. It is better to prepare separate sets of tables, each giving comparisons, etc. of a couple of different categories for the data.

The tabulated data can be usually put in the form of suitable *graphs, histograms, curves, polygons, smoothed curves, bar charts*, etc. Each of these is specially suited to certain types of data. It should be noted that while the appropriate graphs, curves, etc. exhibit and clearly bring out the relevant aspects of the data, the use of unsuitable polygons, etc. may prove quite misleading and confuse the facts. The results of a dozen students on a couple of general ability tests can be eloquently expressed in a series of a dozen comparative bar charts (one for each individual). But when this data is presented as a couple of polygons superimposed on the same graph, the figure simply confuses the issues. The reason is obvious, the several candidates do not form a single continuous series with graduated intervals. But when both the sets of scores are located as points along two axes, then we could get a *scatter-gram* which would be useful for calculating correlations. In doubtful situations, it is a wise policy to consult the laboratory authorities.

The *statistical calculations* of the results are methods for expressing the data in a concise form, without losing any of the salient aspects. A large series of quantitative judgements can be put into a single representative figure, as the *Mean*. But this information becomes almost complete, for most practical purposes, when supplemented by the figure for *standard deviation*. Similarly the correlation between two abilities, or the *significance of the difference* between two mean values from two groups of data, tells us a very great deal in a nutshell. These values also make our results specially meaningful. If we look upon statistical treatment as a useful method for abbreviating the raw data, and for bringing out the important results for every body's appreciation, we can consider the statistical task from a more friendly angle, than as an unavoidable and a disagreeable duty. It may be added for the benefit of the non-mathematics-knowing readers, that the task of statistical calculations can be simplified a great deal by the use of common *Logarithmic Tables*. Each student can easily learn, and he should learn to simplify the rather formidable looking tasks of multiplication and division by converting them into simple problems of logarithmic addition and subtraction. The use of tables for squares, square-roots, and reciprocals, would further go to simplify almost all the tasks in the calculation of psychological data. The addition, or subtraction, or the taking down of required numerical data from printed tables is certainly not a very difficult task for any student interested in experimental psychology. And, if there be one who finds these tasks too onerous or very difficult, then he had better stay outside a laboratory of psychology, and try more congenial fields.

7. *Remarks* (*or Comments*): These may be of a general nature and cover a very wide range. They may refer to the theoretical, or even historical aspects having some connection with the given

experiment. We find that the *results* of an experiment can be usually described in some quantitative terms. The numerical expression of the various aspects of the data and the relations between them give us *statistics*. This information, however, needs to be interpreted in psychological terms. Each experiment is performed to obtain data which will either establish some well-known theory or hypothesis ; or to determine in the case of the given observer some aspect of a well-known and universal fact *e.g.* the *colour-zones* of the retina, or the blind spot, can be determined for a given observer. The shape of the colour-zones may corroborate the hypotheses regarding the relative size and extent of the said zones in the nasal, temporal, top and bottom parts of the retina. Again, a study of *memory* for sense-materials and non-sense materials could indicate the advantages enjoyed by the element of *meaning*, if any. Such a psychological interpretation is given towards the end of the report of an experiment in the form of *remarks*, along with any special aspects of the data, or of the course of the experiment, or of the peculiarities of the given observer. Sometimes the different portions of our observations seem to fall into a single plan, and these indicate the probability of a general rule or principle of explanation. At other times, while some observations are of one kind, there are a few others of a different kind. Here we may either have two different hypotheses to explain the said differences in the data or we may adopt a more comprehensive hypothesis, which due to the limiting operations of other conditions give us apparently different groups of data.

There is also an occasion for *remarks* by *E* on some peculiarity of procedure, or observations by the given *O*, or any mishap or accident during the period of the said experiment ; such materials usually form the basis for the remarks. Even when all goes well, and the experimental results simply bear out the expected conclusions of some well-established principle, it is possible to clearly bring out the said aspect of the observations. It could be done in a couple of lines. But in some laboratories, the practical note-book is also supposed to serve the dual purpose of an experimental text, and the students are required to write a brief historical sketch of the connected topic and the method employed. In a sense, such information is essential to clarify the problem which is being investigated. This is sometimes given along with the title of the problem. However, this understanding of the 'problem' is implicit in the very undertaking of the experiment. Hence, such remarks are considered inessential by others.[2] In our opinion, a brief reference to the hypothesis implied in the observations of the said experiment, as well as the fact of its corroboration or otherwise during the given experiment, should be the burden of some remarks. Further, *when the results are at variance* with the hypothetical expectation, it is necessary to *try to explain* the character of the said variation. It is also possible to suggest *variations of the procedure*, materials, etc., with a view to a better understanding of the given hypothesis. Such suggestions form a legitimate part of the remarks. The tabulated results and statistics merely present the comparative picture to one who knows the statistical symbolism employed. The *remarks* can certainly clarify the comparative aspect of the experimental data in a more intelligible language. Further, 'remarks' is also the place for indicating the relationship between the *O*'s introspective commentary and the objective facts.[3]

The *report* of the experiment should be written immediately after the experiment is over, and the data has been subjected to the required statistical analysis. The written report should be submitted for the signature of the laboratory authorities or the lecturer-in-charge.[4]

Some students try to write the note-book in many coloured inks. This desire to make the said book look ornamental is childish indeed. A neat and clear presentation of the experiment and its data are required. Putting them in an ornate form is an unwarranted waste of time and labour and hence (in our opinion) such a display is undesirable among senior or graduate students.

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[2] Much would depend upon the traditions of a given laboratory, or the desires of a given instructor.

[3] Any such attempt will exercise *E*'s ability to *note* and to *think out* the probable *relations between recorded behaviour and mental processes.* These remarks will provide an occasion to *recall* and *apply* his theoretical knowledge of Psychology. In the absence of such attempts we have merely a mechanical description of data, which is bereft of much meaning. Such a situation is sometimes considered to be an ample exhibition of both a lack of insight and a poverty of scientific curiosity.

[4] In short, specific remarks would (*i*) explicate the final results, including some interpretation of certain aspects of the statistical treatment; (*ii*) bring out the peculiarities of the responses, or of the variations of technique, and (*iii*) in other ways point out any relations of the given data with other experiments performed by himself or reported in scientific literature.

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# QUALITATIVE

[Note regarding the abbreviated reference to Tables in the *qualitative* series of experiments.

The information regarding the preparing of tables for the data has been abbreviated in the case of the *qualitative* series. Any *Table* can be conveniently represented by a reference to its columns, and to the content titles (or *stubs*) for the given columns. We have described the columns *from left to right,* and numbered them as 1, 2, 3, etc. Thus Table I in Experiment No. 1, could be described as: 1 Serial Number; 2 Exposed Length; 3 Reproduced Estimate. This would indicate that there are *three* main columns; the *first* contains the Serial Number of the observation; the *second* contains the corresponding stimulus or Exposed Length; and the *third*, the observed response, or Reproduced Estimate. In subsequent experiments, the Tables for data are to be prepared according to the directions given under the head of Results.]

# EXPERIMENT 1

## Problem

To determine the subjective errors of observation.

**Observer**

**Date & Time**

## Material

Tachistoscope; Cards for exposing standard lengths of lines; a large card with a window to expose small widths of the record sheet.

## Procedure

(*i*) The *O* is seated comfortably, facing the tachistoscope. An area of the record sheet with 1 written near the margin on it is laid before him, and a pencil is put nearby. He is instructed as follows: "When I say *ready*, attend to the centre of the cross on the tachistoscope screen. After a short while, I will lift the screen and expose a line on the card, at the same place. You have to estimate the given length, and mark two points on the record sheet at a distance *double* of the given line. Mark first a point near the left hand edge. Now pull the record sheet upwards to screen the marked points, and write 2 at the left edge of the exposed area of the record sheet. I will again say *ready*, and on hearing that you should attend to the centre of the cross on the tachistoscope screen. Soon after I will expose another card with a line upon it. You must again estimate double the distance and mark two points on the record sheet; but this time you must first mark a point near the right hand edge. Afterwards you must again pull the record sheet upwards, and again write the next number. In this way I will expose several cards, and you will give your estimates, until I ask you to *stop*."

(*ii*) After six practice observations, ask *O* to write (or dictate) introspective comments with special reference to sensations of movement, the type of images and sensations used for estimation of 'double the distance' and the experience during the marking of the said estimate on the record sheet. Movements of the eye-lids, eye-balls, and of arm and finger muscles should be particularly attended to.

(*iii*) There should be at least 3 cards with *standard* ($S_s$) lines of 25, 50 and 100 mm. The lines are to be exposed in a non-consecutive order, *or* in a mixed *chance* order. In short we are not to practice with *one* length only.

Take at least *one set* of 10 readings each, for each of the given standard lengths. The 30 estimates are measured separately, and analysed into sets of estimates 'from the right edge' *i.e.* all *even* estimates, and 'from the left edge', *i.e.* all *odd* estimates. The total results are averaged and the averages compared as proportions.

RESULTS

(*a*) The results are tabulated as follows :

TABLE 1

RAW RESULTS

| *Ser No.* | *Exposed length* | *Reproduced estimate* | *Ser No.* | *Exp.* | *Rep.* |
|---|---|---|---|---|---|
| 1 | 50 mm | *abc* | 11 | .. | .. |
| 2 | 25 mm | *def* | 12 | .. | .. |
| 3 | .. | .. | 13 | .. | .. |

TABLE 2

COMPARING ESTIMATES

| $S_s$ | 25 *mm* *Marked from* | | 50 *mm* | | 100 *mm* | |
|---|---|---|---|---|---|---|
| | *Rt.* | *Lt.* | *Rt.* | *Lt.* | *Rt.* | *Lt.* |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| Ave : | | | | | | |
| Tot Ave : | | | | | | |

(When $X$ = the value of any one estimate ; $\Sigma$ = Sum of ; $N$ = Number of observations ; the Mean = $M = \Sigma X/N$).

Take the minimum estimate in all series as $Sj = 0$. Find the differences (or $D$) for each estimate by $D = X - Sj$. Then for a given set, correction for Mean (or $C = \Sigma D/N$); and Standard Deviation (or $S.D.$) $= \sqrt{(\Sigma D^2/N) - C^2}$. Thus $M = Sj + C$.

(*b*) Introspective comments should be combined together to indicate the probable experience of $O$ in the given situation.

*Note :* To prepare the *chance* order, get a pack of playing cards. Take 10 cards each from 3 different suits, each to represent one length of standard stimulus ($S_s$); shuffle them well, then distribute and find out the order from this pack.

## EXPERIMENT 2

### PROBLEM

To find the character of isolated visual experiences.

### MATERIALS

A stop clock; a flash-light; paper for recording introspective comments.

### PROCEDURE

(*i*) The *Observer* (*O*) is asked to sit comfortably. He is instructed: "When I say *ready*, you will shut your eyes and attend to your visual experiences. Kindly give as detailed a description as you can. Take a special note of the hues and their contours. If the field of visual experiences changes, then describe the said changes. You will go on reporting your experiences until I ask you to *stop*, when you will open your eyes and take rest." Usually the report is obtained for 1 minute. Take 6 reports, giving 1 mts rest interval.

(*ii*) In some series the flash-light may be turned on for 10 seconds intervals on *one*, or on *both* the closed eyelids. Note if this leads to any difference in the report of the hues or of brightnesses present in the visual field. In the *later* series, the *O* may be asked to report only the experiences of the right eye, or only of the left eye. (If no flash-light is available, then *O* may be seated facing a window, which can be opened or closed by *E* as required.)

### RESULTS

The results have to be analysed for any specific patterns, variations or sequences.

## EXPERIMENT 3

### PROBLEM

To discover the characters of images.

### MATERIALS

List of words : (*i*) 10 words indicating concrete objects ; (*ii*) 10 words referring to persons ; and (*iii*) 10 abstract words ; sheets for records.

### PROCEDURE

(*i*) The *O* is seated comfortably. He is instructed : "When I say *ready*, please close your eyes. In a few moments, I will speak a word. Note the image that arises, for a few seconds. I will ask you to report certain aspects of your image-experience. When I tell you to *stop*, open your eyes and take rest."

(*ii*) At first use some concrete class-words, *e.g.* chair, house, cloud, tree, etc. Enquiry is directed : Is it a familiar chair ? What is the colour of the chair-image ? What is its size ? and shape ? Where is it ? Facing which way ? Above or below you ? Are you sitting upon it ? If not, can you see yourself sitting on it ? Can the image be made to move its position, or location, etc. ? What is the degree of vividness, or of clearness of the said image, or its changes ?

(*iii*) Use words meaning persons, *e.g.* friend, merchant, thief, etc.

(*iv*) Use some abstract words, *e.g.* wealth, happiness, honesty, etc. In each case enquire about the images, and their variations, if any. Special attention is to be paid to shapes, contours and symbols etc.

### RESULTS

(*a*) The vividness of the images are noted on a 5-point scale :

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| life-like ; | very clear ; | average ; | partly clear ; | quite vague. |

(*b*) Try to discover the *imagery type* of the *O*.

(*c*) Compare the average *vividness* of the three kinds of images, and the average number of variations.

*Note:* Take words that may be expected to evoke auditory, tactual, gustatory and olfactory imagery.

## EXPERIMENT 4

### PROBLEM

To determine the character of controlled attention.

### MATERIALS

A foolscap sheet marked with 5 thin crosses at intervals of 4 to 5 inches. An order for suggesting shifts of attention during the experiment.

### PROCEDURE

(*i*) The *O* is seated comfortably, and the paper with the crosses is put on a screen in front, at a distance of some 14″. *O* is instructed: "When I say *ready*, close your eyes. After some seconds I will ask you to *open* your eyes and concentrate your attention on one of the crosses by saying 'centre' [or top, or bottom, or (your) right, left]. You do so. After some time I will ask you to turn your eyes to another cross, and so on. You signal by moving your finger upwards when you are focussed upon the centre (inter-section) of the given cross. If your attention wanders, signal by moving the finger sideways. Please do as you are bid until I ask you to *stop.*"

(*ii*) Take 4 records with 6 shifts in each time interval. After half a mt. suggest a shift every 10″. Later, suggest shifts after 15″, 20″ and 30″. Big shifts, that is 'top to bottom' are interspersed with small shifts, right to top, top to centre, etc. from one record to another.

(*iii*) Enquire while focussing the central cross, "what is the size of the visual field ?" After a while direct: (*a*) try to reduce this field ? Describe this field. Describe the processes that have brought about this change. What are the processes that restrict the field ? muscular ? imaginal ? (*b*) Try to expand the field 'attended to'. Describe the changes that occur. (*c*) Compare the clearness of the impressions from the centre, with those from the periphery in the field of attention. Note the changes in the relations between the different areas of the field during shifts, and during restriction, etc.

## EXPERIMENT 5

### PROBLEM

To map the colour zones of the retina.

### MATERIALS

Perimeter; some colour stimuli; cloth for blindfolding one eye of the *O*; recording discs.

*The Perimeter.* It is an apparatus in which there is a metal arc that can be rotated in any direction, and kept fixed at any angle. There is an adjustable chin-rest: It is so adjusted that the pupil of *O*'s eye is at the same level as the *centre* of the given metal arc. On the back side there is a recording device to record on a paper disc. There is also a colour holder to move the colour stimuli from the centre outwards along the metal arc, or inwards. The metal arc is supposed to occupy the position described by a point moving in a circle, with the pupil as centre, and a radius equal to the distance from the pupil to the central point of the metal arc. Thus the metal arc when rotated on its centre, goes through all the radii along the surface of a hollow sphere reflecting the orb of *O*'s eye, or its retinal surface. Any stimulus moving along this arc projects an impression upon an appropriate point of the *retina*, but in the reverse order, *i.e.* if the stimulus is on the right of *O*, its impression will fall upon a point on the left side of the retina. And, when the stimulus is above the level of the eye, its impression will fall upon the lower portion of the retina, and so on.

*The recording disc.* It is made of some concentric circles, with 8 or more diameters running through at equal intervals. Thus when the metal arc is put in a directly vertical position above or below, one of the said diameters should lie along the measuring scale at the back of the perimeter disc, which revolves on the same axle as the said perimeter metal arc. When the colour stimuli are moved and transition points located, then just as its position can be read on the arc, it can be marked along the given diameter of the recording disc.

*The colour stimuli.* These are square patches whose sides are ¼″ in length; or circles with ¼″ diameter.

PROCEDURE

(*i*) The *O* is seated comfortably. The chin-rest is adjusted. The eye that is not to be explored is blindfolded, and the *O* is given some time to get adapted to the situation. The position of the perimeter is marked on the table, to avoid chance of accidental displacement in the course of the experiment. The perimeter arc is put in a position directly vertical above the eye, and the diameter of the recording disc at the measuring scale, is adjusted if necessary and marked 270°. A colour stimulus is chosen and placed at the centre of the metal arc. Now *O* is instructed: "Please look at the colour before you. Do not move your chin, or the eyeball, but keep the eye focussed upon the centre before you (or where the stimulus is being shown now). I will move the stimulus by gradual steps, but you are not to move the eye at all. If you find any change in its impression, describe the same aloud. Sometimes I will move the colour stimuli away from the centre, and sometimes towards the centre." (Each *outward* series of observations is followed by an *inward* series to neutralise the bias due to the *movement* of the stimulus in any given direction.)

RESULTS

(*a*) The table of raw results is drawn up as follows:

| *Arc direction* | *Retinal radius* | *Transition point* | | *Average* | | *Final Remarks* |
|---|---|---|---|---|---|---|
| | | *Out* | *In* | *Out* | *In* | |
| Level | 0°(1) | | | | | |
| | (2) | | | | | |
| Bottom | 90 (1) | | | | | |
| | (2) | | | | | |
| Nasal | 180 (1) | | | | | |
| | (2) | | | | | |
| Top | 270 (1) | | | | | |

(*b*) The results are to be shown on graph paper.

*Note.* The results may be taken for *both* the eyes, and if desired along other diameters.

(*ii*) The transition points are noted. Usually 2 sets of readings are taken in each position, and the values of the transition points are averaged for the two series, as well as again averaged for all the 4 series of observations (*i.e.* 2 outwards, and 2 inwards). This final average is noted on the diameter of the recording disc in terms of the scale given there. Now, the arc is adjusted to another angle say 45° in a clockwise direction, the new diameter is marked 315° for the right eye (or 225° for the left). [It is assumed that the diameter enabling the exploration of the nasal side of the retina at the level of the *O*'s pupil is to be called zero degree.]

## EXPERIMENT 6

### PROBLEM

To determine the size of the blind spot.

### MATERIALS

Screen; foolscap sheet; bandage for blindfolding one eye; stimulus thistle; chin-rest.

### PROCEDURE

(*i*) Two lines are drawn length-wise, in the middle of the sheet running from edge to edge, parallel to each other and at a distance of 1″. Draw a thin cross in the middle of these two lines near the left edge for exploring the left eye, and *vice versa*, for the right eye. Paste (or pin) this paper on the screen, and put the screen at a distance of about 12″ from *O*. The Observer is seated comfortably and the chin-rest is placed for him. The eye that is not being explored is blindfolded. The screen is so adjusted that the cross is in front of the eye that is being explored and at its level.

(*ii*) The stimulus on the tip of the thistle is usually a black ¼″ square or a ¼″ circle. This is brought near to the cross on the *top* line. *O* is instructed: "When I say *ready*, please focus your eye on the intersection of the cross, and do not move the eye-ball when I begin to move the stimulus. After sometime you will not be able to see the given stimulus; kindly tell me by saying *gone*; again after sometime it will appear, please signal that position by saying *come*. When I say *stop*, then you may move the eye-ball but not the chin, until I say *finished*." The given 'transition points' of the blind spot are duly marked on the top line. Then similar points are marked on the *inward* run. The two sets of transition points are halved, and the middle point at half the distance between the said two points is also marked.

(*iii*) Now another set of points is noted on the *lower* line, and the middle point is also marked. Now a vertical line is drawn through the given midpoints, and along this line *E* explores in both the directions towards the top and the bottom. The eye is all along kept focussed at the cross centre. Again the outward and inward (*i.e.*

upward and downward) series yield average point locations. These are joined from the top-most point to the points on the top line, and in the same way from the bottom-most point to the points on the bottom line. The two sets of transition points on the top and the bottom lines are also joined to form an irregular hexagonal figure.

### RESULTS

(*a*) The results may be tabulated as in Experiment 5 with suitable changes in the headings.

(*b*) The size of the actual area of the blind-spot on the retina may be calculated from the facts that the centre or nodal point of the average eye is assumed to be about 15.7 mm from the retina, and it is 7.5 mm from the lens. If $y$ is one of the dimensions of the hexagonal figure, and if $z$ be the corresponding line on the retina, and if the distance from the pupil to the cross centre is measured in millimetres (say $x$) then the proportions of the blind spot can be easily calculated by the formula

$$P = 7.85\, y/(x + 7.50) \text{ mm.}$$

# EXPERIMENT 7

## PROBLEM

To prepare a map of the touch and cold spots from a given area of the skin.

## MATERIALS

A mm-square stamp ; hair holder ; temperature cylinders ; blind goggles (or bandages) ; a razor ; a stamp pad ; an order for exploring the stamped area.

## PROCEDURE

(*i*) The *O* is comfortably seated, stretching the forearm on the table with the palm facing upwards (volar side up). A small area is selected for exploration. It should be free from hair (or it is shaved to remove hair). The area is stamped, and another stamp mark is put on the record sheet. The application of the stimulus to any point in the said area is located by reference to the vertical and the horizontal lines from the origin in the bottom left hand corner (*o*, *o*). The point where the sensation is reported is marked on the map upon the record sheet. Each square area is explored in some predetermined order.

(*ii*) The blind goggles should be put on for a couple of minutes before the exploration begins, and these should be kept on during the experiment.

(*iii*) *Instruction:* "I will say *ready* and shortly afterwards touch some point within the marked area of the skin with the stimulus ; kindly report by saying *yes*, when you get the sensation of touch (or hot, cold, etc.)."

(*iv*) The stimulus should be poised vertically over the point selected for exploration. After saying *ready*, wait for nearly 2″ and then gently lower the stimulus. Remove the stimulus after some $\frac{1}{2}$″ contact. (If there is no response, then try elsewhere.) Note the responses on the record sheet, and jot down any remark, if necessary. After the exploration is over, ask *O* to remove the blind goggles and rest.

RESULTS

(*a*) The stamp area should be measured for its location, from the edges of the wrist and of the elbow. The marks on the stamp show the spots sensitive to the given stimulus (hot, or cold, etc.).

(*b*) When the same area is also explored for other sense-modalities, then the two sets of spots observed can be put together on a single map. Thus we can see how far there is an overlap, clustering, etc.

*Note* 1 : While exploring cold or hot spots, the metal temperature cylinders are put in cold (or hot) water. These should be wiped dry before use and should be replaced with fresh cylinders every 8 seconds or so.

*Note* 2 : Take a special note of spots giving *paradoxical cold* sensation.

## EXPERIMENT 8

### PROBLEM

A study of tactual localization.

### MATERIALS

A large 1″ square stamp for impressing dots ; two plastic thistles. Blind goggles.

### PROCEDURE

(*i*) A record sheet is prepared with 4 impressions of the given square stamp, forming a square with double the base. The central point is marked with a thin cross. *O* is blindfolded, and an area on one of his forearms is marked with a stamp. A thistle is put in his free hand.

(*ii*) *O* is instructed : "I will say *ready* and touch you on a spot. Soon after I remove the stimulus, you should try to touch the same spot with the point of your thistle." A point within the stamped area is lightly touched by the plastic thistle with a somewhat blunt point. *O* also uses a similar plastic thistle to localise the said (touched) spot, soon after. *O* starts moving the hand from a fixed position. The record of each localization is marked in each case from the origin in the intersection of the cross.

(*iii*) Introspective comments are obtained at intervals.

### RESULTS

(*a*) The distance in localization is measured in tenths of an inch (or mm). The direction is written as Above, Below, Right, Left, or a combination, as AR, BL, etc.

(*b*) The results may be tabulated in 3 columns as follows :

(1) *Serial Number*. (2) *Response Distance*. (3) *Direction*.

(*c*) Find out the average error and direction of localization.

(*d*) Analyse the introspective comments.

*Note :* In other experiments the localization may be attempted, after some interval, say 2 or more seconds after the stimulation.

## EXPERIMENT 9

### PROBLEM

A study of auditory localization.

### MATERIALS

A stool; piece of chalk; blind goggles; buzzer; electric keys; connecting wires; a metre wooden scale; three clips.

### PROCEDURE

(*i*) A circle about 4 feet in diameter is drawn round the centre of the stool. A line is drawn through the centre and 8 points are marked on the circumference at 45° each.

(*ii*) The buzzer and its key are clipped on to the metre scale, and duly connected with batteries.

(*iii*) The *O* is blindfolded, and made to sit so that both his ears are along the central diameter. He is instructed as follows: "I will say *ready*, and shortly afterwards, you will hear the buzzer. Kindly point out the direction in which you hear it by moving the required arm and the fore-finger. But you are *not* to move or shift in your seat, nor move your neck. A few seconds later, you will again hear the stimulus, and again point out the said direction. This will go on until I ask you to *stop*; then you can remove the blindfold and take rest."

(*iv*) The buzzer is raised to the level of the ears on the point of the circle, and it is sounded for ½ to 1 second. The points are stimulated in a haphazard order. The exploration is done at each point, and the whole set of readings may be obtained more than once.

### RESULTS

(*a*) the results are recorded in three columns as follows:

(*i*) Point Stimulated. (*ii*) *Direction reported.* (*iii*) *Remarks.*

*Note* 1: The quadrants are described by reference to *O* as front-right; right-back; back-left; left-front, etc.

*Note* 2: If required the quadrants may be further subdivided into two or more parts.

## EXPERIMENT 10

### PROBLEM

To study the influence of repetition of the task on memorising (meaningful materials ; method of *reproduction* or recall).

### MATERIALS

4 lists of 16 familiar words each ; a stop watch ; A set of cards (or a memory drum), one for each word.

### PROCEDURE

(*i*) The lists of words are selected for the first and later presentations. Each word of the given list is written in big and legible characters on a small card. A place is marked for exhibiting the cards containing the task for memorising. The first word is exposed after the *ready* signal for 2″, and the rest follow every two seconds. After the complete list has been gone through the pack is picked up, and immediately the first card is again exposed, and the rest succeed every 2″, until the said list has been exposed (or repeated) as many times as desired (*or* the list is placed upon the memory drum for presentation).

(*ii*) The *first* list is exposed 8 times, and immediately thereafter the *O* is asked to reproduce the said list. The *second* list is exposed 6 times ; the *third* for 4 times, and the *fourth* list only twice.

(*iii*) The *O* is seated comfortably. The location for the exposure of the memorising list is pointed out to him. He is instructed : "When I say *ready*, kindly attend to the exposure point. Soon you will see there one word, and after a couple of seconds another, until the whole list is exposed. The list may be repeated. You should try to memorise the words in the list. Later, you will be asked to reproduce them in the same order, in which they are being shown to you now. This list will be shown to you 8 times."

After the reproduction has been obtained, give rest for 4 mts. Then say, "Now I will show you another list. This will be shown 6 times (or......times). [The time allowed for reproduction is 4 minutes. If more time is needed that may be deducted from the *rest* period].

RESULTS

(*a*) The list is scored (*i*) for total correctly reproduced; and (*ii*) for the total reproduced correctly in the proper order. If there are two or three words correctly reproduced in their order, they are scored irrespective of any gaps or wrong reproductions before, or afterwards.

(*b*) The reproduction record is put in tabular columns as follows: (*i*) *Word*; (*ii*) *Reproduced*; (*iii*) *Right*; (*iv*) *Position rt.*; (*v*) *Remarks.*

(*c*) The scores for the two formulae in note (*a*) are put for comparison in columns: (*i*) *Repetitions*; (*ii*) *Score-i*; (*iii*) *Score-ii*; (*iv*) *Remarks.*

## EXPREIMENT 11

### Problem

Influence of memorising effort on meaningless tasks.

### Materials

4 lists of 16 meaningless dissyllables each.

### Procedure

As in Experiment 10.

### Results

As in Experiment 10. Scores may also be compared with the scores for meaningful material. Group results may be correlated.

*Note :* Rules for preparing dissyllables : The successive dissyllables should *not* (*i*) begin with the same letter, (*ii*) *nor* end with the same letter, (*iii*) *nor* rhyme together. Lists may be prepared in English script or in Hindi :

GABIL, PENOD, FISAK, LABUN, SOMIG, PANAD, etc.

(गाबल, पिनड, फ़िसक, लबून, सोमग, पनड, इत्यादि · · · )

## EXPERIMENT 12

### PROBLEM

Influence of the degree of learning on memorising (method of *recognition*).

### MATERIALS

A task-list of 20 words for memorising; a recognition list of 80 words (or 80 cards with one word on each); screen; record sheets.

### PROCEDURE

(*i*) As in Experiment 10.

(*ii*) Show the given list of 20 words once. Now replace the 5th, 10th, 15th and 18th words by 4 new words (which are in the recognition list). This should take 1 mt. After the second exposure, replace the 3rd, 7th, 12th and 17th words with another 4 new words (available in the recognition list). After the third exposure, replace 4th, 8th, 14th and 16th words, with 4 fresh words (as before). After the fourth exposure, show the entire recognition list one by one for 4″ each, and ask *O* to write down the recognised words, and give their confidence scores.

(*iii*) The exposed pack of cards is brought behind the screen for making necessary changes. Thus the new exposure should begin after 1 mt.

(*iv*) The *O* is instructed: "After I say *ready*, I will start showing to you a number of words one by one. Each word will be shown to you for about 2″. When the whole list is exposed, you will have 1 mt. for rest. You may try to recollect the said list of words, if you like. After 1 mt. the list will be again exposed to you with some changes. This procedure will be repeated twice again. Afterwards I will give you a record-sheet, and start showing you the *recognition* list which contains all words exposed to you and many others. You will write down the word that you believe was shown to you in the memorising list, and you should also indicate the *degree of your confidence* in the said recognition by noting: — 3 = certainty, 2 = probability, 1 = vague possibility."

(*v*) The exposed words as well as the recognition list cards are divided into 3 or 4 parts each, and each pack is shuffled thoroughly. All the eighty words are pooled together and the whole pack further shuffled. It is this well-shuffled pack which is exposed one by one for *recognition*.

RESULTS

(*a*) The record sheet is prepared in 2 columns as follows: (*i*) *Recognised word*; (*ii*) *Confidence*. The results are further analysed in a table with columns: (*i*) *Serial No.*; (*ii*) *Word*; (*iii*) *Degree of learning**; (*iv*) *R/W*; (*v*) *Confidence score*.

(*b*) The memory score is calculated: 2R—W.

(*c*) Determine the influence of the degree of learning by preparing a table with columns for (*i*) *Degree of learning*; (*ii*) *Score R*; (*iii*) *Score* W; (*iv*) 2R—W; (*v*) Total confidence score (*a*) R, (*b*) W; (*vi*) *Remarks*.

*Note 1:* The recognition list consists of 20 words of the *task-list*; 20 words which are commonly *associated*; and 20 words with similar *meaning* as the words in the *task-list*, and 20 unrelated words.

Compare proportions of erroneous or *false* recognition among associate words, synonyms and others.

*Note 2:* The scores for the individuals in the group may be correlated with the scores in earlier experiments.

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* The number of times the given card is exposed for memorising.

## EXPERIMENT 13

PROBLEM

A study of association of ideas (*free*).

MATERIALS

A list of 50 common words (nouns and adjectives); stop-watch ; a screen ; record-sheets ; blind-goggles.

PROCEDURE

(*a*) *Auditory :* (*i*) The Observer is seated comfortably, and he is instructed as follows : "When I say *ready*, kindly close your eyes.* Soon after I will speak some word. As soon as you get any idea or word associated with it, you say that aloud. If the idea is simple, you can express it in a single word. But if the associated idea is complex, then you can describe it in a phrase or a short sentence. I will write that down, and then I will speak another word and you will give the idea or associated word with that. We will go on like this until the whole list is finished, when I will say *stop*. Then you can open your eyes and take rest."

(*ii*) The time for association is recorded by the stop-watch. The stop-watch is started while speaking the first syllable of the stimulus word, and it is stopped on hearing the first syllable of the response. (Some stop-watches give time in 1/5ths of a second. This should be kept in mind while reading them).

(*iii*) The list may be repeated for a second set of times and response.

(*b*) *Visual* (*i*) The *O* is seated comfortably with a blank record sheet and instructed : "When I say *ready*, kindly attend to the exposure-point. As soon as you see the stimulus word and an associate idea comes to you, kindly write the same before 1. If the idea is simple, you can express it with a single word. But if the associated idea is complex, then you can describe it in a phrase or a short sentence. Now turn to the exposure-point, and I will show you the next word, and you will write its associated response before 2, and so on until we finish the list. When I say *finished*, you take rest.

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* When blind-goggles are used, say "put on the blind-goggles".

(*ii*) The time for association is noted by starting the stop-watch with the exposure of the stimulus word and by stopping it the moment *O* starts writing the response. (The list may be repeated for a second set of times and responses).

RESULTS

(*a*) The observations are recorded in a table under the following columns : (*i*) Stimulus word ; (*ii*) Time ; (*iii*) Response word ; (*iv*) Type ; (*v*) Remarks.

(*b*) The associated responses may be analysed in various ways. The scheme of analysis should be decided beforehand, and the type of each association written in the given column. Remarks refer to peculiarities of psychological background, if any.

(*c*) The times are averaged. When there are a small number of extreme timings these may be rejected.

(*d*) Try to give a psycho-diagnostic interpretation, if possible. The extreme timings are carefully commented upon.

*Note :* Another experiment can be performed by presenting one stimulus word to *O* and by his responding with a *chain* of associations. It is assumed that each response word also acts as a stimulus for the next response. Here, the whole series of responses are obtained for 2 minutes. Then the types of associations are determined, and a psycho-diagnostic interpretation is attempted.

## EXPERIMENT 14

### PROBLEM

To determine times for *constrained* association of ideas.

### MATERIALS

Several lists of 10 or 12 words each ; stop-watch ; screen.

### PROCEDURE

Auditory as in Experiment 13. The instruction is modified to suit the type of constrained association desired, *e.g.* Part-whole ; opposite ; subordinate-super-ordinate ; etc. "I will show you a word which means a *part* of an object, you should give the word meaning that whole ;" etc.

### RESULTS

The results are analysed for average times. Remarks are expected for very quick or very late responses. The differences among the various average times should be compared and the character of the constraint commented upon.

# EXPERIMENT 15

## PROBLEMS

A study of imagination (*vividness*).

## MATERIALS

Lists of words indicating objects subserving different sense-modalities.

## PROCEDURE

(*i*) The Observer is seated comfortably and is asked to put on blind goggles. He is told to be *ready*, and thereafter the words of the list are read out one by one. *O* is instructed : "When you hear the stimulus-word, you will get some image. Kindly describe the image as being visual, or auditory, etc. Also, mention the *vividness* of the given image on a 5-point scale : 5 = Very life-like ; 4 = Quite vivid ; 3 = Average ; 2 = Partly vague ; 1 = Very vague. When the list is finished, I will ask you to *stop* and rest."

## RECORDS

(*a*) The results are recorded in the columns of a table as : (*i*) Stimulus word ; (*ii*) Image modality ; (*iii*) Vividness ; (*iv*) Remarks.

(*b*) The results are also analysed for average vividness of the different modalities. The extremes of vividness need further enquiry and introspective comments.

*Note :* The results of a group may be pooled and averaged to determine the peculiarities of individuals.

# EXPERIMENT 16

## PROBLEM

To find out the *imagery type* of a given *O*.

## MATERIALS

A stop-watch ; record sheets.

## PROCEDURE

The *O* is seated comfortably. He is given a blank ruled paper and instructed as follows : "When I say *start*, then you will write words expressing objects that can be recalled by *visual* (or. . . . . .) images. You will be given 2 minutes to write. Try to write as many as you can. When I say *stop*, then you will stop after completing the word that was being written. Is it alright ? Ready ! Start !"

(The instructions are changed to suit the needs for tactual, auditory, etc. imagery). Last of all, ask *O* to write *any* words for the same period. The period may be varied to 3 or 4 minutes, if necessary ; but it should be kept uniform for all sections of the experiment.

## RESULTS

The results of a whole group should be taken together and averaged to decide the peculiarities of the different individuals.

## EXPERIMENT 17

### Problem

A study of learning new visuomotor coordination (*mirror drawing*).

### Materials

Mirror-drawing apparatus; double lined star figures; drawing pins; stop-watch; screen.

### Procedure

(*i*) The *O* is seated comfortably, and the apparatus is placed in such a way that, while he can easily see the image in the mirror of the given star figure, he is effectively screened from looking directly at the said star figure. The stars are always placed (pinned) in the same position, and the *O* is instructed to begin always from a given point or angle. He is required to trace between the lines of the said figure in a general direction (clockwise, or opposite). After *O* gets ready and picks up the pencil, his hand should be guided by *E* to the starting point. He is also instructed to keep his wrist and elbow *free from any contact* with the table or the apparatus. He is given the *ready* signal and then asked to *start*, and the stop-watch is also started at the same time. The total time taken to complete the tracing is recorded.

(*ii*) Take 15 trials without any rest with one figure (5-point). Now give rest for 5 minutes, and take 15 trials with the 2nd figure (6-point), giving 5 minutes for rest after each series of 5 trials.

### Results

(*a*) Draw a curve of the times taken for the 15 trials with the first figure. Draw a similar curve for the second figure, giving the rest gaps in *broken* lines.

(*b*) Take a record of errors for the last 10 trials with each figure. Each contact with or a crossing of the limiting lines is to be counted as one error. Draw a curve of errors.

(*c*) Compare the shapes of the two sets of curves, and discuss the so-called advantages of massed learning *vs.* spaced learning.

## EXPERIMENT 18

### PROBLEM

A study of habit formation and reversal (*Card sorting*).

### MATERIALS

A card sorting tray with 3 × 4 pigeon holes ; stop-clock ; a pack of playing cards.

### PROCEDURE

(*i*) The card-sorting tray is placed on the table. *O* is seated comfortably in front. The pack is shuffled and given face downwards to *O*. He is told to cut and then to *deal* the cards one by one ; to turn each up and to put that in the appropriate pigeon-hole. He is asked to sort the pack as quickly as he can. If there is any mistake in the sorting of a card, then that is pointed out by *E* and duly corrected. *E* should be very alert to note these errors. The time taken for each complete sorting is noted. The numbers of errors are also recorded. The tray is tilted to throw out the cards. The cards are reshuffled by *E* for the next trial.

(*ii*) *O* is given 6 practice trials, and then the tray is turned on one side. He takes *one* trial (test) and after that test the tray is reset in the former position ; and then *O* is again given 6 more practice trials. Again the tray is turned (but) on the other side, and *O* takes a test trial.

### RESULTS

The test-trial time and errors are compared with the scores of the initial practice attempt, as well as with the scores of the last practice trial.

*Note :* If the *O* is very quick and makes very few errors, then the test trial may be run after only 3 or 4 practice trials. The main purpose is to measure the effect of reversal upon a partially formed habit, with one of double the given strength.

## EXPERIMENT 19

### PROBLEM

To measure the span of attention.

### MATERIALS

A set of cards with varying number of dots; a short duration tachistoscope.

### PROCEDURE

(*i*) The *O* is seated comfortably before the tachistoscope. He is instructed: "When I say *ready*, kindly attend to the cross on the tachistoscope screen. Soon after I will show you a card with some dots for a fraction of a second. You have to give me the number of the said dots. After some time, I will again say *ready* and show another card, and you will give me your estimate of the number of dots again. In this way, we will continue till I ask you to *stop*. Then you can take rest."

(*ii*) The set of cards is shown in an ascending order of dots, until the subject makes many mistakes. Now this shortened set of cards may be repeated 2 or 3 times, to determine the maximum number possible for a correct estimation by *O* in a single act of attention.

### RESULTS

The results are tabulated in columns as follows: (*i*) Serial No.; (*ii*) Card No.; (*iii*) Actual No. of Dots; (*iv*) Estimated No.; (*v*) Right/Wrong.

*Note:* If the whole set is exposed 10 times, then the results may be analysed for a percentage of estimates by *O*.

## EXPERIMENT 20

### PROBLEM

To determine the maximum duration of attention to a minimal stimulus.

### MATERIALS

Masson's disc; colour wheel; kymograph; kymograph sheets; electro-magnetic markers; keys; connecting wires; commutator; spring time marker; stands; screen; varnish bottle and varnishing and drying equipment; Smoky burner and smoking stand.

### PROCEDURE

(*i*) The kymograph-drum is fitted with a glazed white paper, which is blackened with an even coat of soot. The drum is fitted on the kymograph; the speed is adjusted to give one revolution in about 3 minutes; and the electro-magnetic stylus is put in contact with the smoked paper on the drum at the required height.

(*ii*) The electrical connections are laid from the battery through the key as well as the commutator, and tested.

(*iii*) The Masson's disc is mounted on the colour wheel, and placed before a screen, facing the Observer. (Some practice trials are given to *O* to determine the minimal ring, for a minute or so).

(*iv*) The observer is instructed: "When I say *ready*, kindly place your fore-finger upon the button of the *push-key*, and close your eyes. On hearing *start*, open your eyes and look at the minimal visible *ring* on the colour wheel. Keep your eyes focussed on that ring and press the key once; after a while this ring will *disappear*. When it does so, again press the key once. After some time the said ring will *reappear* and you signal that by pressing the key once again. In this way you go on signalling each disappearance and reappearance of the given minimal ring, until I ask you to *stop*. Then you can take rest."

(*v*) Start the colour-wheel, say *ready*, start the kymograph, and soon after say *start*. Take observations for some 2 minutes. If necessary take another record by readjusting the height of the electro-magnetic stylus, about an inch *lower* than the former records.

Then take the time-record with the spring time marker, set at ½″. Take off the *kymogram*, inscribe the necessary legends, varnish the record and put it up to dry.

### RESULTS

Find the length of the time marker record for a 10″ interval. Measure in mm. the distance between the signals for appearance and disappearance. The initial and final stretches of the record should be rejected. The results are tabulated in columns marked: (*i*) Serial No.; (*ii*) Interval (mm.); (*iii*) Remark (Disappearance or appearance).

The lengths of the space intervals for *appearance* only are averaged, and this interval converted into time in seconds. The longest interval is also converted into time to determine the maximum duration of attention.

*Note:* Since the speed of the kymograph is kept constant, only one line of the *time record* should be enough. But, if the speed is altered, or suspected of changing, then the time record should be simultaneous with *O*'s record of attention. In such cases, the recorders should be adjusted to give fairly parallel records.

## EXPERIMENT 21

### PROBLEM

A study of thinking : Concept formation (*Prompting* method).

### MATERIALS

4 sets of eight cards, each containing 4 words including *one* belonging to a specific class, and marked at the back with a symbol ; long exposure tachistoscope.

### PROCEDURE

(*i*) The cards are shuffled thoroughly. They are exposed one by one for 4″ to 5″ each. The specific symbol for each card is also spoken aloud by *E* while he is exposing any given card. After all the 32 cards have been shown, *O* is expected to speak the symbol for each card as it is re-exposed. If *O* cannot give the symbol, or if he gives a wrong symbol, then he is corrected or informed the correct symbol. Each such incident of information is scored as a *prompting*, and a record (or tally) is kept for each card, and every set.

(*ii*) *O* is comfortably seated and instructed : "I will show you some cards with a number of words written upon them. The class of these words is symbolised by a special syllable (or word), that I will speak aloud along with each card. You have to try to discover the particular class of objects represented by that symbol. After I have shown all these cards, I will again show them to you and you will try to tell me their correct symbols. If you are wrong, then I will speak the correct symbol. We will try to see how soon you can learn the various symbols. Is it all clear ? When I say *ready*, kindly attend to the exposure point."

(*iii*) Introspective commentary is obtained as soon as two symbols are learnt correctly. A further commentary may be taken after all the four symbols have been identified correctly.

### RESULTS

(*a*) The *raw* results are recorded in columns marked : (*i*) Serial No. ; (*ii*) Card No. ; (*iii*) Symbol ; (*iv*) Promptings. The promptings are entered as tallies. These results are further analysed for the groups of different symbol cards, and tabulated in columns for (1) Card No.; (2) Symbol-i; (3) Symbol-ii; (4) Symbol-iii; (5) Symbol-iv. [See Osgood (1953), pp. 668f.].

## EXPERIMENT 22

### PROBLEM

A study of reasoning.

### MATERIALS

*Survey of Reasoning* booklets, in which each given argument is to be marked, Absolutely True (AT), Probably True (PT), Indeterminate (I), or Absolutely False (AF).

### PROCEDURE

The booklets are distributed to the group. The instructions are read and explained. The group is started on the test proper. After the time is up, the booklets are collected and scored.

### RESULTS

(*a*) The individual scores are recorded in columns (*i*) Serial No. ; (*ii*) Premises and conclusions ; (*iii*) AT, (*iv*) PT, (*v*) I, (*vi*) AF.

(*b*) The results are analysed for proportions of answers to groups of *premises*, *e.g.* 1 Premises ; 2 per cent AT ; 3 per cent PT ; 4 per cent I ; 5 per cent AF.

*Note :* The premises alone can be grouped as Affirmatives, Affirmative-Negative, and Negatives. A further analysis may be carried out considering the conclusions, as well as the *universal* or *particular* quantity of the premises and conclusions.* But this is a very laborious process and need not be attempted by everybody.

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* This may be described by logical symbols : *A* = Universal-affirmative ; *E* = Universal-negative ; *I* = Particular-affirmative ; *O* = Particular-negative.)

## EXPERIMENT 23

### PROBLEM

A study of personality traits (*ranking*).

### MATERIALS

Papers and pencils.

### PROCEDURE

The papers and pencils are distributed to the group. They are told: "As you have been working together for some time, it is assumed that you have formed some notions about certain personality traits of your colleagues in this group, present here today. I will write some trait on the blackboard. You may then proceed to rank the members of the group (writing initials on the board) for that trait in a column, as 1, 2, 3, etc. Rank *one* means the highest category for the given trait in this group, *e.g.* for *honesty*, rank 1 would mean 'most honest'. But sometimes the traits are negative, *e.g.* cowardliness. In this case *also* rank 1 would mean 'most cowardly'. Is it all clear? Ready! "*Rank for* . . . trait."

### RESULTS

(*a*) Each individual's results are arranged for a specific and uniform order of the members of the said group.

(*b*) The various rank-orders are *correlated* for each individual, and it is possible to discuss the patterns of the quality-clusters for some given traits. The results of the various individuals may be further compared with each other for interesting similarities and discrepancies.

*Note:* Find the rankings for leadership, honesty, industry, self-sacrifice, cowardice, obstinacy, selfishness, intelligence, beauty, height, etc.

## NOTE ON CORRELATION TECHNIQUES

### (A) PRODUCT-MOMENT CORRELATION FOR SMALL SAMPLES, WITHOUT FINDING MEANS FOR THE VARIABLES. (*Pearsons r*).

The two sets of variable scores for each individual are arranged under columns for $X$ and $Y$. Values are also calculated for each $X^2$, $Y^2$ and $XY$; as well as for their respective sums : $\Sigma X$ ; $\Sigma Y$ ; $\Sigma X^2$ ; $\Sigma Y^2$ ; and $\Sigma XY$. The correlation is obtained by the formula :

$$r_{xy} = \frac{N\Sigma XY - \Sigma X \Sigma Y}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2]\,[N\Sigma Y^2 - (\Sigma Y)^2]}}$$

### (B) PRODUCT-MOMENT CORRELATION AFTER ASSUMING MEANS.

This technique is most suitable when the scores of the variables $X$ and $Y$ are in whole numbers. As the calculated means for $X$ or $Y$ are likely to contain some decimal quantities, the nearest whole number is taken as the Assumed Mean (AM). Thus the difference ($d_x$, or $d_y$) is positive, when the real mean is *higher* than AM ; and it is *negative* when the real mean is *lower* than the AM. (Each difference of the AM will be *less* than ·5.)

The data for the individuals is now arranged for the given variables, and the deviations from the mean are readily calculated, as well as squared, each being a whole number whether positive or negative. The deviations from the means are called $x$ and $y$. The product of $xy$ is conveniently arranged under two adjacent columns, one for positive and another for negative products. In other words we get the data in the following columns : Variable $X(V_x)$ ; $V_y$ ; $x$ ; $y$ ; $x^2$ ; $y^2$ ; $xy(+)$ ; $xy(-)$. The sums for the columns $x^2$ ; $y^2$ ; and $xy$ are calculated as $\Sigma x$, $\Sigma y$, and $\Sigma xy$. Let $n =$ the no. of individuals. The correlation is found from the formula :

$$r_{xy} = \frac{\Sigma xy - n.dx.dy}{\sqrt{[\Sigma x^2 - n(d_x)^2]\,[\Sigma y^2 - n(d_y)^2]}}$$

(C) RANK DIFFERENCE METHOD OF CORRELATION (*Spearman's rho*).

The two variables are separately arranged in ranks according to the descending order of their scores. When two or more individuals have the same score, then each of them will obtain their common *average* rank, *e.g.* when the rank placings for 7 and 8 are occupied by individuals with the same score, then each of the said individuals will be given the average rank, *i.e.* $(7 + 8) \div 2 = 7 \cdot 5$. Again, if the rank placings 5, 6 and 7, are all occupied by individuals with the same score, then each of them will be given the average rank of $(5 + 6 + 7) \div 3 = 6$.

Each individual is given his rank according to the rankings of the given two variables ; $R_x$, $R_y$. The difference between these two ranks for each individual is calculated as $D$. If $n =$ the number of individuals ; then the rank difference correlation (*rho* or $\rho$) is calculated by the formula :

$$\rho_{xy} = 1 - \frac{6\Sigma D^2}{n(n^2 - 1)}$$

The Probable Error of a correlation is found by the formula :

$$PE_r = \cdot 675 \frac{1 - r^2}{\sqrt{n}}$$

$$\text{and } PE\rho = \cdot 706 \frac{1 - \rho^2}{\sqrt{n}}$$

## EXPERIMENT 24

### PROBLEM

A study of suggestibility (*Line estimations*).

### MATERIALS

A set of cards with 3 cards each having lines of 50, 55, 60, 65, 70, 75, and 80 mm length.

### PROCEDURE

(*i*) The Observer is comfortably seated before the long exposure tachistoscope. He is instructed as follows: "When I say *ready*, kindly attend to the cross on the screen. Soon afterwards I will expose there a card with a line of a certain length. After a couple of seconds I will screen that card and show you another line. You have to quickly judge this line and report its length as equal, shorter, or longer than the previous line. In each case you have to judge the present line in comparison with the earlier line. This will continue, until I ask you to *stop*, then you can relax and take rest."

(*ii*) The cards are exposed sometimes in an irregular order, and occasionally in an ascending or descending order, followed by a couple of exposures of equal lengths. (These *test* suggestibility.)

### RESULTS

(*a*) The *raw* results are serially recorded in columns showing: (*i*) Serial No.; (*ii*) Stimulus Line; (*iii*) Report.

(*b*) The record is analysed to discover the tendency for 'suggestibility'.

*Note:* At first an ascending (or descending) set of 4 lines is followed by the set of equal lines to the preceding one. If the test indicates some suggestibility; the test situation is to be repeated in the reverse direction. Later, one may try a set of only 3 ascending (or descending) lines followed by the test set of 2 lines equal (to the preceding one).

# QUANTITATIVE

## EXPERIMENT 25

### PROBLEM

To find the average reaction-time of an individual for simple (*i*) *sensorial*, (*ii*) *motor* and (*iii*) *choice* visual situations.

*Statistical Techniques:* Calculation of Mean, $SD$, $SE,_M$ $\sigma_{\text{diff}}$, $CR_\sigma$, with grouped data; Mode, Median; the use of random number tables.

### MATERIALS

One Vernier Chronoscope; electrical battery giving 2.5–3.5 volts with connecting wires; 1 spring-key, a 4-way key; card-board screen with stands; 2 iron stands with cross-heads and adjustable clamps; 2 bulb-holders with 2 volt bulbs or an exposure box.

(*i*) The *Vernier Chronoscope* is a simple instrument by which the variation in speeds of two pendulums released by $E$ and $O$ respectively, enable us to measure the reaction-time in units of 1/50th of a second.

$E$'s pendulum is adjusted to give 75 swings per minute, *i.e.* it takes $0.8''$ for one complete oscillation. $O$'s pendulum is adjusted to a slightly *faster* speed; it's 40th swing should coincide with $E$'s 39th swing. Thus $O$'s pendulum is moving at 1/40th of a swing faster than the pendulum released by $E$. In short, it is overtaking the slower $E$'s pendulum at a constant rate of $0.8/40'' = 0.02''$ per (its own) oscillation. This is known as the *Vernier* constant.

Hence $E$ has to count the number of *complete* oscillations run by $O$'s pendulum, till its swing coincides (or *seems nearly to coincide* with the swing of $E$'s pendulum. (A *nearly coincident* swing is to be given adequate care, as each reaction may take a little more or less than a unit multiple of the given constant of $0.02''$. For example, 10th coincident swing means, $RT = .20''$; and 11th coincident swing will mean, $RT = .22''$. But, if the true *reaction time* is $.208''$, $.210''$ or $.218''$, etc., then the 10th or the 11th swings will be *nearly coincident* only. *If this fact is overlooked* then the next nearly coincident swing would occur after 20 or more swings: Thus the *RT would be nearly doubled*).

(*ii*) Some Vernier chronoscopes are fitted with electrical connecting-points. The connections with the battery and stimulus circuits differ in the different makes of chronoscopes. In each case, a pressing of *E*'s key releases the *E*'s pendulum and simultaneously presents the electrical stimulus — a flash of light. (Sometimes the light-flash is obtained by *breaking* a short-circuit through the base, and in others this occurs through the *making* of the stimulus circuit.)

(*iii*) The electrical keys are placed and connected according to the *plan* of the electrical arrangements, drawn beforehand by *E*. The 4-way key is specially required for the *choice-reaction*experiments only.

The *screen* is so arranged that *O* cannot see the hand of *E*, when he says "Ready" and is prepared to press *E*'s key ; also when *E* is re-arranging the stimulus connections, counting the swings or recording them.

(*iv*) The clamps with bulb-holders are so adjusted that the *bulb* is nearly *level with the eyes of O*, when he sits with his finger upon the response-key.

[In the case of *choice-reaction* the two bulbs should be quite near to each other. One bulb may be coated with red-ink (or covered with red tissue paper. If possible, a small tissue paper screen, say 2″ × 2″ over an exposure window of a grey card-board screen could be used to cover the bulb-holder with the light-point (or points)].

(An *exposure box* contains an arrangement for using a white, red or other coloured light. The light is seen through a 1″ circular ground glass screen. A thin black cross is marked on the centre of the said screen.)

(*v*) The battery, bulbs and bulb-holders should be tested before use. The screws for the connecting wires should *not be* loose, but screwed fairly tight.

*Instructions :* The *instructions* to *O* should be typed or written in a clear and legible hand, and kept before *O* throughout the course of the observations.

(*a*) Instructions for *simple sensorial* reaction : "*When I say 'ready', attend to the light* (*or screen*) *and place your finger upon the response-key.* When you see the light, react as soon as you can. Do *not* react until you see the light. React quickly."

(*b*) Instructions for *simple motor* reaction : As above from "when I say. . . to. . . response-key". "React as soon as you see the light. React as quickly as you can. React immediately."

(c) Instructions for *choice reaction :* "When I say 'ready', attend to the light stimuli,* and place your right hand fore finger on the right-hand response-key, and your left hand fore finger on the left-hand response-key. When you see the *white* (yellow) light, press the right-hand key ; and when you see the *red* light, press the left-hand key. React as soon as you can. *Do not react until you are sure* of the stimulus and the proper response. React quickly."

PROCEDURE

After arranging the apparatus and satisfying that it is in good working order, *O* should be seated and instructed *specially* for the given series of observations.

The stimulus should be presented about 1″–2″ after the 'ready' signal. Some 5–10 practice reaction-times should be taken. But they may not be considered for calculation of the results.

The *results* of 25 to 50 *RTs* under each instruction should be observed and recorded according to their serial order, as in Table 3.

TABLE 3

| *Ser. No.* | *RT in swings* | *RT in seconds* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| etc. | | |
| etc. | | |

The *Calculations* require a tabulation of the data among convenient *grouped units* (or intervals). We should first of all determine the *range* of the responses *in swings*. The range should be divided into 10–15 steps of equal intervals or grouped units. Then the *frequencies* (*f*) for each group should be analysed. The middle (or nearly middle) group is *assumed* as the *Mean*, and other steps are noted as *plus* or *minus* deviation (*d*) step units. Now we count $fd$ and $fd^2$. The value of the *AM* is taken as at the mid-point of the *assumed mean* interval (*vide* Table 4).

$$[N = \Sigma f\,;\ i = \text{step interval in units}\,;\ c = \Sigma fd/N\,;$$
$$M = AM + ci\,;\ SD = i\sqrt{(\Sigma fd^2/N) - c^2}\,;\ SE_M = SD/\sqrt{N}.]$$

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* Or screen.

(If any extreme frequencies are separated from others by one or more zero-frequency steps, then these *may be* neglected, and not taken up for computation of $M$ and $SD$. In such cases, $N$ should be duly corrected.)

The final results are multiplied by the constant ·02 to convert the swings into seconds.

TABLE 4*

| *Step* | *f* | *d* | *fd* | *fd*² |
|---|---|---|---|---|
| 17–18 | 1 | —2 | —2 | 4 |
| 19–20 | 4 | —1 | —4 | 4 |
| 21–22 | 8 | 0 | $AM = 21.5$ | |
| 23–24 | 4 | +1 | 4 | 4 |
| 25–26 | 3 | +2 | 6 | 12 |
| 27–28 | 2 | +3 | 6 | 18 |
| 29–30 | — | | | |
| 31–32 | 2 | (We shall neglect these) | | |
| 33–34 | — | | | |
| 35–36 | 1 | | | |

$N = 22$ ; $i = 2$ ; $c = 10/22 = \cdot 45$ ;
$M = 21.5 + 2 \times .45' = 22.40$

$SD = 2 \times \sqrt{(42/22) - .20} =$
$2 \times \sqrt{1.79} = 2.68$

(Multiplying $M$ and $SD$ with 0.02″ we have $M = .448''$ or .45 seconds $SD = .0536''$ or .05″)

* Data from S. C. Gupta.

Determine $M$, $SD$, and $SE_M$ for the various simple, and the choice reaction-times. Now find out the differences between the Mean times. Now find $CR\sigma =$ (difference between means)/$\sigma_{\text{diff.}}$ ($\sigma_{\text{diff.}} = \sqrt{SE_{M_1}^2 + SE_{M_2}^2}$). See how far $CR\sigma$ indicates a *significant* difference between the various reaction attitudes.

*Note* 1 : Some persons convert each reaction observation into seconds at first, and then carry out the calculations. But the suggestions given above are more convenient. Only, *do not forget that the reaction-time must be some quantity in seconds* (and not in swings).

*Note* 2 : The frequency data from the grouped step-intervals may be also used for preparing a *histogram* of the data. Also, it could be used for calculating the *mode* and the *median*.

*Note* 3 : The experiment may be modified to obtain reaction-times to sound, or electric shock ; or choice between two sounds — a bell and a buzzer, etc.

*Note* 4 : The choice stimuli should be presented in a *random* order obtained from a table of random numbers.

*Note* 5 : If grouping of data is not attempted ; then we can first take the *arithmetical mean* of the entire set of readings $\left(M = \frac{\Sigma X}{N}\right)$. Then by ignoring the decimals, we can obtain an Assumed Mean ($AM$), and the deviations $x$, and $x^2$ values. Then the true $SD$ is found by using the correction ($c$), which will be always less than ·5, in the formula : $\sigma_x = \sqrt{\frac{\Sigma x^2}{N} - C^2}$.

# EXPERIMENT 26

## PROBLEM

To determine the *upper difference threshold* for lifted weights.

*Method and Statistical Technique:* Method of *constant stimuli:* 2-category response. (Also called, the *constant method;* the method of *constant stimulus differences;* the *frequency method;* and the method of *right and wrong cases*). Technique of *interpolation — linear*, as well as *normal;* Spearman's *summation method.*

## MATERIALS

A set of six hollow wooden tubes 3″ × 1″, fitted with caps; lead shots; a scale with a box of weights; a screen; blind-goggles; cloth pad for the forearm; a chart of haphazard or non-consecutive presentation of the variables; a tabulated record sheet.

(*i*) Fill two tubes with shots to weigh 50 gms. each; and fill the others to weigh 52, 54, 56 and 58 gms. respectively. The tube-caps should be securely fixed, and may be marked with their respective weights, or with letters of the alphabet.

(*ii*) The chart for a *non-consecutive* presentation of the variable stimuli should be prepared by *E* for 10 or 20 sets of observations. This order is to be repeated, if necessary, for obtaining the total number of observations, that is 50 each or 100 each. In the *tabulated record-sheet* space should be provided for the recording of responses in symbols, as +, =; or *H*, *E;* etc. [All responses will be *Heavier* or *Equal,* during $S_s$ 1st; and *Lighter* or *Equal,* during $S_s$ 2nd. A *doubtful* response (?) is to be calculated as equal].

In one case the following chart was prepared:

| *Ser* | *A*=50 | *B*=52 | *C*=54 | *D*=56 | *E*=58 | *A* | *B* | *C* | *D* | *E* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1–10 | 2 | 1 | 4 | 3 | 5 | 7 | 6 | 8 | 10 | 9 |
| 11–20 | 11 | 15 | 12 | 14 | 13 | 18 | 20 | 16 | 19 | 17 |
| 21–30 | 22 | 21 | 25 | 24 | 23 | 30 | 28 | 27 | 29 | 26 |
| 31–40 | 32 | 31 | 33 | 35 | 34 | 36 | 40 | 37 | 39 | 38 |
| 41–50 | 43 | 45 | 41 | 44 | 42 | 48 | 46 | 49 | 47 | 50 |

## PROCEDURE

The screen is so arranged that *O* can pass his forearm through a gap. *O* is asked to keep his open fist in a vertical manner over the table. A gap of about $1\frac{1}{4}''$ is to be kept between the thumb and the fore or middle finger. *E* says 'ready', and then places a tube ($S_s$) on the cloth over the table between the open thumb and fingers of *O*. *E* says 'first' (or 'yes'), then *O* grips the said tube, and lifts it about $\frac{1}{2}''$ by moving the wrist, and then replaces the same and releases his hold. Now *E* removes that tube and takes another tube ($S_v$), according to the order of stimulus presentation, and again *E* says 'ready', and later 'second'. *O* lifts the second tube and then judges the same as 'Equal', or 'Heavier' (greater) than the first lifted weight. The comparative judgment is always in terms of the *second experience* as *being equal, greater or heavier than the former*. This procedure is repeated as often as required. In half the observations $S_s$ is presented 'first'; and in the other half, it is presented 'second'.

*Instruction:* "When I say 'ready', open the thumb and fingers for holding the weight-tube. When I say, 'first' (or 'yes'), hold the tube and raise it by moving the wrist-joint for a second or so, then replace it on the table and release your hold. I will remove the given tube, then I will say, 'ready' and place a second tube within your open thumb and finger grip. When I say, 'second', you take hold of the given tube and lift the same. You have to compare this experience with the memory of the former weight, and give your judgment on the 2nd experience by saying 'equal', or 'greater' (or heavier) than the former.* You are not to move the weight many times, hefting is not allowed. You have to move the weight upwards *once* only, and then to leave it on the table."

When $S_s$ is presented 2nd, and $S_v$ is given 1st; then the judgment (*L*) is to be *reversed in record*. However, if the two series are obtained at different times, then it is convenient to go on recording, *E*, *L*, etc. as said by *O*, and then *inverse the final total* of *E* and *L* judgments, in the series $S_s$ 2nd.

## PRACTICE EXPERIMENT

Take a minimum of 10 readings with each variable.

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* During $S_s$ 2nd, the judgment is 'equal' or 'lighter'.

RECORD

The $S_s$ 1st, and the $S_s$ 2nd order of observations are to be analysed separately, totalled together, as well as given in proportions, as in Tables 5A and 5B :

TABLE 5A

| | FREQUENCIES | | | | | |
|---|---|---|---|---|---|---|
| | *Std'd 1st* | | *Std'd 2nd* | | *Total* | |
| $S_v$ | *E* | *G* | *E* | *G* | *E* | *G* |
| 50 *gm* | | | | | | |
| 52 ,, | | | | | | |
| 54 ,, | | | | | | |
| etc | | | | | | |

TABLE 5B

| PROPORTIONS OF JUDGMENTS | | | | | |
|---|---|---|---|---|---|
| $S_s$ *I* | | $S_s$ *II* | | *Total* | |
| *E* | *G* | *E* | *G* | *E* | *G* |

In one case the $S_s$ *I*, was presented 90 times with each $S_v$ and the result in proportions was as follows :

| *Sv* | *Wt* | *E* | *G* | *Remarks* |
|---|---|---|---|---|
| A | 50 gm | .671 | .329 | $<.50$ |
| B | 52 ,, | .429 | .571 | $>.50$ |
| C | 54 ,, | .386 | .614 | |
| D | 56 ,, | .300 | .700 | |
| E | 58 ,, | .200 | .800 | |

The *UDL* is a point where 50 per cent judgments are *E*, and 50 per cent judgments are *G*. This can be *graphically* obtained by drawing *frequency polygons* for *E*, and for *G* (or an *s-p* plot). They will intersect at the *UDL* or the 50 per cent line. (If required, we may draw a smooth curve 'by the eye'). This can be done *only* when the responses go on increasing (or decreasing) in a regular order, as in the example given above.

This transition point (*UDL*) can also be found algebraically by the formula for limen (*L*):

$$L = S_l + \frac{(S_h - S_l)\,(.50 - P_l)}{P_h - P_l}$$

[$L$ = limen;
$S_l$ = $S_v$ immediately lower than the limen.
$S_h$ = $S_v$ immediately higher than the limen.
$P_l$ = proportion for $G$ immediately lower than the limen.
$P_h$ = proportion for $G$ immediately higher than the limen.]

By substituting we get the limen for $S_s$ 1st ($L_1$):

$$L_1 = 50 + \frac{(52 - 50)\,(.500 - .329)}{.571 - .329} = 51.38 \text{ gms.}$$

$\therefore$ Weber's ratio for $L_1 = (51.38 - 50)/50 = .0276$, *i.e.* 2.76 per cent.

(Find $L_2$, and $Lt$ and their Weber ratios).

*Time error:* $e_t = \frac{1}{2}(L_1 - L_2)$

*Note* 1: When the $S_s$ 1st, and $S_s$ 2nd sets of stimuli are presented with *part knowledge* to $O$, he can be restricted to judgments of $E$ or $G$; or of $E$ or $L$ (lighter or lesser). In order to eliminate the possibility of bias due to 'part knowledge', and also to give $O$ greater freedom of judgment, some $E$'s permit $O$ to say as he feels $L$, $E$, or $G$, in each of the sets of *time orders* for the $S_v$. Thus they obtain a record with 3-categories of response. In such cases, the Upper or Lower limen can be obtained by distributing the $E$ judgments according to the proportions of the $L$ and $G$ judgments for the given variables. *Or*, one extreme improbable category ($L$ or $G$) is *neglected* by adding its judgments with Equal ones: Thus we reduce the 3-category results to a 2-category form. Thus the 3-category responses are readily reduced to a 2-category form, and the results obtained by the methods of graphic or algebraic *linear interpolation* given as in the example above.

*Note* 2: When some proportions of judgments are below .25 as well as some above .75, then we can also calculate the 25 per cent $G$-judgment point (or 1st Quartile, $Q_1$) as well, as the 75 per cent $G$-judgment point (3rd Quartile, $Q_3$). We already know the 50 per cent point (*Median* or $Q_2$). Now it is suggested that, $L = \frac{1}{4}(Q_1 + Q_3 + 2Q_2)$ gives us a better estimate as it also takes into account the data from a larger number of the given variables. *E.g.* In one case of Müller-Lyer figure comparisons by the *constant* *method*, the $G$-judgments for $S_s$ = featherhead 2″; $\angle \varnothing$ (*PHI*) = 30°; arms = $\frac{1}{2}$″; each $S_v$ compared 20 times, were as follows:

| $S_v$ | 2.0″ | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 |
|---|---|---|---|---|---|---|
| $f$ | 0 | 2 | 4 | 11 | 16 | 20 |
| $p$ | 0 | .10 | .20 | .55 | .80 | 1.00 |

Data from P. Ghosh.

Here, the Median = 50 per cent limen $= Q_2 = 2.2'' + .086 = 2.286''$

and the 25 per cent point, or $Q_1 = 2.2 + .1 \times [(.05)/.35] = 2.2 + .0014 = 2.201''$

also the 75 per cent point, or $Q_3 = 2.3 + .1[(.20)/.25] = 2.3 + .08 = 2.380''$

Hence, true $L = \frac{1}{4} \times (2.201 + 2.380 + 2 \times 2.286)'' = \frac{1}{4} \times (9.153) = 2.288''$. (The difference between the 50 per cent $L$ and the revised $L = .002''$ only).

The $Q_1$ and $Q_3$ points can also give us an estimate of the *semi-inter-quartile range*, or $Q = \frac{1}{2}(Q_3 - Q_1)$, which can be converted into $SD$ or $\sigma$ by the formula : $\sigma = 1.483 \times Q$. This would give us a useful estimate of the reliability of our data. In above, $Q = .179/2 = .089''$ and $\sigma = .132''$. [Woodworth suggests (p. 408) a smoothed value of Median $= Mdn = \frac{1}{3}(Mdn + Q_1 + Q_3)$; but we have followed the one advised by Guilford (*P.M.*, p. 120)].

*Note* 3 : When judgments are available for several variables, and the proportions also differ from 0.00 to 1.00, then Spearman suggests the *summation method*, in order to take into account the whole range of our observations. We have *also* to depend upon this method, when the responses are highly *irregular*. Thus we hope to discover the common trend of the whole range of responses.

We can describe the $S_v$ with $p = 1.00$ (or assumed to do so) by $S_1$; and the $S_v$ with $p = 0.00$ (or assumed to do so) by $S_o$. We may use $i$ for the constant interval between any two adjacent grades of stimuli; and let $p$ or $P$ be the proportion of judgments in the required category (success or failure), and $p'$ be the *cumulative* proportions. If $M$ be the 50 per cent judgment point; then we have two possible formulae :

(*i*) $M = S_1 - .5i - i\Sigma p$ and (*ii*) $M = S_1 + .5 \times i + i\Sigma P$; and $SD = i\sqrt{2\Sigma p' - \Sigma p - (\Sigma p)^2}$. To select the proper formula for $M$, we have first of all to locate $p = 1.00$. When $p = 1.00$ is the *larger* $S_v$, then we use formula (*i*). But when this is the *lower* $S_v$, then we use (*ii*). For the data in the previous note, we have Tables 6 and 7.

TABLE 6

G-JUDGMENTS

| $S_v$ | $p$ | $p'$* |
|---|---|---|
| 2.0″ | .00 | |
| 2.1 | .10 | .10 |
| 2.2 | .20 | .30 |
| 2.3 | .55 | .85 |
| 2.4 | .80 | 1.65 |
| 2.5 | (1.00) | |
| Σ | 1.65 | 2.90 |

* *Note* : $p'$ = cumulative proportion. The cumulation of proportions begins from $p = 0.00$, but it *never* includes $p = 1.00$.

TABLE 7

E-JUDGMENTS

| $S_v$ | $P$ | $p'$ |
|---|---|---|
| 2.0″ | (1.00) | |
| 2.1 | .90 | 2.35 |
| 2.2 | .80 | 1.45 |
| 2.3 | .45 | .65 |
| 2.4 | .20 | .20 |
| 2.5 | .00 | |
| Σ | 2.35 | 4.65 |

[($P$ of Table 6 is equal to $(1 - p)$ of Table 7]
(*i*) $M$ from Table 4 is obtained by using formula (*i*):
$M = 2.5 - .1 \times .5 - .1 \times 1.65 = 2.5 - .05 - .165 = 2.285''$.

And from Table 2, we have $2.0 + .1 \times .5 + .1 \times 2.35 = 2.05 + .235 = 2.285''$. In the same way, the $SD$ from Table (*i*) will be as follows :

$SD = .1\sqrt{2 \times 2.90 - 1.65 - 2.722} = .1\sqrt{1.43} = .1 \times 1.2 = .12''$. And for table 7 : $SD = .1\sqrt{2 \times 4.65 - 2.35 - 5.52} = .1\sqrt{1.43} = .1 \times 1.2 = .12''$.

*Note* 4 : The *normal interpolation process* assumes that the relation of $p$ to $S_v$ is according to the cumulative normal curve. So we transform the $p$ values into corresponding *deviates* or $x/\sigma$ values of $Z$. Each $p$ below .5 is considered negative ; and each $p$ above .5 is positive. The difference between .5 and $p$ is calculated, and the corresponding $Z$ value obtained from the table of deviates (Guilford, *P.M.*, 559–562).

In the case of the data in the earlier Note 2, we have :

| $S_v$ | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 |
|---|---|---|---|---|---|---|
| $p$ | 0 | .10 | .20 | .55 | .80 | 1.00 |
| $Z$ | 0 | —1.282 | —.842 | +.126 | +.842 | |

The formulae are : $L = S_h - i[Z_h/(Z_h - Z_l)]$
or $= S_l + i \times [-Z_l/(Z_h - Z_l)]$
when $S_h = S_v$ value immediately higher than limen,
$S_l = S_v$ value immediately lower than limen,
$Z_h = Z$ value of $S_h$ ; and $Z_l = Z$ value of $S_l$ ; $i =$ interval.

By substituting the given data, we have

$$L = 2.3'' - .1'' \times [.126/(+.126 - (-.842)]$$
$$= 2.3'' - .1 \times (.126/.968) = 2.287''.$$

(In this case also we consider *only two* values, one immediately above and one immediately below the .50 proportion ; as in linear interpolation).

*Note* 5 : The *UDL* and *LDL* values are sometimes described simply as the *upper limen* and the *lower limen*, and denoted by symbols like $l_u$, and $l_l$ ; or $l_g$ and $l_l$.

*Note* 6 : Determine the *UDL* for (*i*) $S_s = 100$ gms., and (*ii*) $S_s = 150$ gms. ; and compare the Weber ratios obtained $S_v$ may be graded at 4, or 5 gms.

*Note* 7 : If $O$ is very sensitive, and it is noticed during the practice period, the interval between the variables may be reduced to 1, or 2, or 3 gms.

## EXPERIMENT 27

### PROBLEM

To determine the "illusion-effect" for a Müller-Lyer figure.

*Method and Statistical Technique:* The method of *average error.* (Also called the method of *mean error*; of *constant error*; of *reproduction*; of *adjustment*; and of *equivalents*). Analysis of variance.

### MATERIALS

A Müller-Lyer figure with arrangement for varying the length between the *feather-head* points. The *standard* being the *arrow-head*, line length 60 mm, $< \varnothing = 30^\circ$ ; arms 12 mm.

A stiff card-board with 3 slits, and the arrow-head figure drawn from the middle slit. A strip of paper wide enough to keep its position and slide easily between the given slits, with a feather-head on a line 90 mm. This strip can slide to the right or left, by an easy pull. At the back of this strip, the line is marked in millimeters, and it is visible only to *E*.

### PROCEDURE

(*a*) The apparatus is set up within easy reach of Observer. In the first half of the observations, $S_v$ may be on *O*'s right (*R*); and in the second half on *O*'s left (*L*). In each set of observations, *R* and *L*, the same *series order* Outward (or Inward) is repeated for half the set of observations; and it is reversed for the other half. *O* should be asked to start with a $S_v$ obviously much greater in half the series, that is for *movement inwards* (or I); and he should start with an $S_v$ obviously much smaller in the other half for *movement outwards* (or *O*). For *practice experiment*, take four variable outwards (*VO*), and 4 variable inwards (*VI*) observations, with $S_s$ on *R*; and a similar number of readings with $S_s$ on *L*.

(*b*) *Instruction:* You see that in this figure, the distance between the (*AH*) points is *constant*; but the distance between the (*FH*) points is variable. I will make the variable obviously shorter (or greater) than the constant standard figure. You have to make the variable equal to the given standard by pulling it outwards (or inwards).

*A complete counterbalancing* of the *space* (R and L) and *movement* (O and I) conditions can be obtained by the 8-set sequence : RI, LO, LI, RO ; and LO, RI, RO, LI, observation.

Take eight sets of 10 observations each, under the abovesaid conditions of space and movement. Give a rest of 2 minutes after the 4th set. (After each observation, $S_v$ is readjusted, but to a point somewhat greater or smaller than for the preceding observation of the series.) $E$ should *randomize* the settings among large, medium and small initial lengths for $S_v$, if possible.

*Testing for the homogeneity of the data :* Tabulate the data for *RI*, *RO* ; and for *LI*, *LO*. Find out the *minimum* value in all these series, and take that = 0 (zero) ; and find out the $\Sigma x$ and $\Sigma x^2$ for each as follows :

(Code : $Sj$ — minimum = $O$)

| | *I* | | *II* | | *III* | | *IV* | |
|---|---|---|---|---|---|---|---|---|
| | *RO* | | *RI* | | *LO* | | *LI* | |
| Ser. No. | $x_1$ | $x_1^2$ | $x_2$ | $x_2^2$ | $x_3$ | $x_3^2$ | $x_4$ | $x_4^2$ |
| *a* | | | | | | | | |
| *b* | | | | | | | | |
| etc. | | | | | | | | |
| *n* | | | | | | | | |

$$M = Sj + /\Sigma x_1/n \,;\ \sigma x_1 = 1/n . \sqrt{n\Sigma x^2{}_1 - (\Sigma x_1)^2}$$

We have,

$$\begin{array}{llll}
\Sigma R = \Sigma x_1 + \Sigma x_2 \,; & & \Sigma R^2 = \Sigma x_1^2 + \Sigma x_2^2 \\
\Sigma L = \Sigma x_1 + \Sigma x_2 \,; & & \Sigma L^2 = \Sigma x_3^2 + \Sigma x_4^2 \\
\Sigma O = \Sigma x_1 + \Sigma x_2 \,; & & \Sigma O^2 = \Sigma x_1^2 + \Sigma x_3^2 \\
\Sigma I = \Sigma x_2 + \Sigma x_2 \,; & & \Sigma I^2 = \Sigma x_2^2 + \Sigma x_4^2 \\
\Sigma T = \Sigma O + \Sigma I \,; & & \Sigma T^2 = \Sigma O^2 + \Sigma I^2 \\
(\text{also} = \Sigma R + \Sigma L \,; & & \quad\ \ = \Sigma R^2 + \Sigma L^2)
\end{array}$$

$$Mj = \text{Mean of all judgments} = \frac{1}{4n}\left(\Sigma x_1 + \Sigma x_2 + \Sigma x_1 + \Sigma x_2\right) + Sj.$$

Now we can see whether $D/\sigma_{\text{diff}}$ is insignificant in the case of the above $O$ and $I$, or of $R$ and $L$ series. But each such estimation of *Mean* will neglect the movement or the space condition. Since each $R$ or $L$ is also at the same time mixed with an $O$ or an $I$ condition ; it is necessary to proceed with an *analysis of variance*, with a *two-way* classification. The above data may be arranged in Symbolic form as follows :

|  | $N$ | $R$ |  | $N$ | $L$ |  | *Total* |  | $N$ |
|---|---|---|---|---|---|---|---|---|---|
| $O$ : | $n$ | $\Sigma x_1$ | $\Sigma x_1^2$ | $n$ | $\Sigma x_3$ | $\Sigma x_3^2$ | $\Sigma O$ | $\Sigma O^2 = \Sigma x_1^2 + \Sigma x_3^2$ | $2n$ |
| $I$ : | $n$ | $\Sigma x_2$ | $\Sigma x_2^2$ | $n$ | $\Sigma x_4$ | $\Sigma x_4^2$ | $\Sigma I$ | $\Sigma I^2 = \Sigma x_2^2 + \Sigma x_4^2$ | $2n$ |
| $\Sigma$ : | $2n$ | $\Sigma R$ | $\Sigma R^2$ | $2n$ | $\Sigma L$ | $\Sigma L^2$ | $\Sigma T$ | $\Sigma T^2 =$ | $4n$ |

In one case the following results were obtained :

(Code : $Sj - 45 = O$)*

|  | $N$ | $R$ |  | $N$ | $L$ |  | *Total* |  | $N$ | *Mean* |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  | $\Sigma x$ | $\Sigma x^2$ |  | $\Sigma x$ | $\Sigma x^2$ | $\Sigma x$ | $\Sigma x^2$ |  |  |
| $O$ — | 20 | 140 | 1294 | 20 | 124 | 917 | 264 | 2211 | 40 | 6.6 |
| I — | 20 | 56 | 348 | 20 | 100 | 618 | 156 | 966 | 40 | 3.9 |
|  | 40 | 196 | 1642 | 40 | 224 | 1535 | 420 | 3177 | 80 | 5.25 |
| $M$— |  | 4.9 |  |  | 5.6 |  |  |  | $(Mj)$=50.25 |  |

* Data of S. R. Gupta.

(1) *Total Sum of Squares :* $\Sigma x^2_t = 3177 - (420)^2/80$
$= 3177 - 2205 = 972$ (Therefore $C = 2205$)

(2) *The Sum of the Squares between the four sets :*
$\Sigma d^2_{rk} = (140^2 + 56^2 + 124^2 + 100^2)/20 - \text{C}$
$= 48112/20 - 2205 = 200.6$ ($r$ =row ; $k$ =column)

(3) *The Sum of the Squares between the rows :*
$\Sigma d^2_r = (264^2 + 156^2)/40 - C = 145.8$

(4) *The Sum of the Squares between the columns :*
$\Sigma d^2_k = (196^2 + 224^2)/40 - C = 9.8$

(5) The Sum of the Squares of *interaction :*
$\Sigma d^2_{rxk} = \Sigma d^2_{rk} - \Sigma d^2_r - \Sigma d^2_k = 200.6 - 145.8 - 9.8$
$= 45.0$

(6) *The Sum of the Squares within the Sets :*
$\Sigma x^2_s = \Sigma x^2_t - \Sigma d^2_{rk} = 972 - 200.6 = 771.4$

The above results may be summarized as follows :

| *Source* | *Sum of Squares* | *Degrees of freedom (df)* | *Variance*[1] | *F-ratio*[2] | *Significance*[3] |
|---|---|---|---|---|---|
| Space ($s$) | ($\Sigma d^2_k$) 9.8 | $(k-1)=1$ | 9.8 | 0.97 | $p<.05$ |
| Movement ($m$) | ($\Sigma d^2_r$) 145.8 | $(r-1)=1$ | 145.8 | 14.36 | $p>.01$ |
| Interaction ($s \times m$) | ($\Sigma d^2_{rxk}$) 45.0 | $(k-1)$<br>$(r-1)=1$ | 45.0 | 4.43 | $.01>p$<br>$p>.05$ |
| Within Sets | ($\Sigma x^2_s$) 771.4 | $(n-rk)$<br>$=76$ | 10.15 | | |

(1 = Sum of Squares divided by *df*. 2 = Variance divided by 'within the Sets' Variance. 3 = See $F$ — Table, with $n_1 = df$ (greater $= 76$ ; $n_2 = 1$). Significance of $F$-ratio $= 4.00$ is 5% ; of $7.00 = 1\%$ level.

(*a*) *Constant error :* $e_c = S_s - M_j = 60 - 50.25 = 9.75$ mm.

There is a constant under-estimation of the Standard Arrow-head figure as compared with the Variable Feather-head.

Therefore, the required Illusion effect $= 9.75$ mm ; or 16.246 per cent.

(*b*) *Space error :* $e_s = \frac{1}{2}|M_R - M_L| = \frac{1}{2}|49.9 - 50.6| = \frac{0.7}{2} =$ 0.35 mm.

$M_R$ is .35 mm less than $M_j$ ; and $M_L$ is .35 mm greater tha $M_j$.

(*c*) *Movement error :* $e_m = \frac{1}{2}\,|Mo - M_I| = \frac{1}{2}\,|6.6 - 3.9| = 1.25$ mm.

When $S_v$ is moved *outward* the mean error is $+\ 1.25$ mm ; and when *inward* it is $-\ 1.25$ mm.

*Note* 1 *:* The number of $O$ and $I$ series is equal, but each $O$ series is not followed by an $I$ series. (The $O$ is an *ascending* series, and the $I$ is a *descending* series).

*Note* 2 *:* The experiment may be modified to compare a straight line, or a visual extent on the right with another on the left, by means of similar apparatus or with a Galton's bar. Also we could compare a vertical line with a horizontal line.

*Note* 3 : If possible, the following further experiments may be tried :

(*i*) $S_s$ = Arrow-head ; and $S_v$ = A straight line.
(*ii*) ,, = Feather-head ; $S_v$ = (*a*) Arrow-head ; (*b*)=A St. line.
(*iii*) The angle of $S_s$ may be altered to 15, 45, 60 degrees.

*Note* 4 : The errors $e_c$ and $e_s$ will be *reduced*, if the *O* is allowed to vary his adjustment of $S_v$, (*i*) by slowing down when he reaches the point of subjective equality, or (*ii*) to revise his movement, if necessary.

*Note* 5 : *CE* can also be obtained by taking $S_s$ = Assumed Mean ; by finding the frequency distribution of *error* scores, *i.e.* $X - S_s$. Then $CE = \Sigma fe/n$ ; $SE^2 = \Sigma fe^2/n$ (sometimes *SE* is called 'systematic error'); $SD^2 = SE^2 - CE^2$ ; and $M_j = S_s + CE$. (Woodworth, p. 397).

*Note* 6 : This method of average error can also be used for determining *DL*. But the *SD* thus obtained is slightly lower than the *SD* found by the method of constant stimulus differences (discussed in Experiment 26).

*Note* 7 : The Weber's constant may be also obtained by *SD*/*M* ; or by *PE*/*M*. (*PE* is equal to .6745 *SD*).

## EXPERIMENT 28

### PROBLEM

To determine the 2-pt threshold from a given area. [To find out R. L. (Reiz Limen) for two-point contact].

*Method and Stat. Tech.:* Method of *minimal changes* with part knowledge (Titchener).

### MATERIALS

Aesthesiometer; a scale in millimetres; blind goggles; a card-board screen; a cloth-pad.

A light compass with dull points is to be preferred to the heavy, sharp-pointed, and self-regulated metal aesthesiometers. A simple tool can be prepared by cutting two strips of semi-stiff, cover-board sheets, 2″ × 1/3″, tapering them on one end, and joining the flat ends together by means of a paper-clip. The distance between the two points of this card-board aesthesiometer has to be adjusted with the help of the millimeter scale.

The *blind goggles* are to be worn by *O*, when the observations are in progress. The *screen* enables *E* to shield his record sheets.

The *cloth-pad* should be marked by chalk on the table; and the position of the fore-arm of *O* should be marked by chalk on the cloth-pad. The location of the skin-area should be described by reference to the outward points on the right and left of the wrist, as well as the outer right and left edges of the elbow. A pencil line may be lightly drawn in the middle of the area, running from the palm towards the middle of the elbow-joint.

### PROCEDURE

The responses are usually restricted to two categories, plus and minus (+, or −), or yes and no (*y*, or *n*). When a 'doubtful' (?) response is given, it is taken to indicate a transition point. In each observation, the point of *first change* of judgment is to be noted. The *RL* is obtained by calculating one-half of the sum of the *just noticeable difference* and the *just not noticeable difference* $[RL = \frac{1}{2}(jnd + jnnd)]$, Müller.

*Practice experiment:* For the first *ascending* series, begin from $S_v = O$. Go on increasing $S_v$ by 5 mm, until you get the first 2-point (or doubtful) judgment. Now increase $S_v$ by 20 to 30 mm, and start the *descending* series of exploration. Again go on reducing the aesthesiometric 2-pt interval by 5 mm after each observation, until $O$ gives the 1-pt (or doubtful) judgment. In this way, take 10 readings; 5 ascending + 5 descending. Now find out the *widest range* between the 1-pt and the 2-pt judgments. (This is usually an interval of 20–30 mm).

*Experiment Proper :* Start the first ascending series with $S_v$ = the minimum interval of the range, found during the practice experiment. This should evoke the 1-pt response. Now go on increasing $S_v$ by 1 mm; until you reach the first changed judgment, that is 2-pt (or '?'), and note this point. Now take a jump of 5 to 8 mm, and proceed with the *descending* series of exploration. (By a jump of 5 to 8 mm, we mean that it is *not a constant* step. It varies from one observation to another. Such variation is necessary to avoid the errors of *habituation* and *expectation*).

If ascending series be $a$, and descending be $d$; then each $a$ series is followed by a $d$ series, and *vice versa*. Each $S_v$ is presented for 1″, and followed by some 4″ rest. Each *limen-estimate* is $\frac{1}{2}(jnd + jnnd)$.

For 20 observations, the experimental *design* may be $a$, $d$, $a$, $d$, $a$; rest $d$, $a$, $d$, $a$, $d$; rest; $a$, $d$, $a$, $d$, $a$; rest, $d$, $a$, $d$, $a$, $d$. Each set of 5 readings is followed by a rest period of 1 minute. ($O$'s commentary may be obtained during the rest period).

RESULTS

The results may be put in a record-sheet as follows :

| *2-pt distance* | *I* | | | | | *II* | | | | | *III* | | | | | *IV* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *a* | *d* | *a* | *d* | *a* | *d* | *a* | *d* | *a* | *d* | *a* | *d* | *a* | *d* | *a* | *d* | *a* | *d* | *a* | *d* |
| 21 *mm* | | | | | | | | | | | | | | | | | | | | |
| 20 ,, | | | | | | | | | | | | | | | | | | | | |
| .. | | | | | | | | | | | | | | | | | | | | |
| .. | | | | | | | | | | | | | | | | | | | | |
| 14 | | + | | | | | | | | | | | | | | | | | | |
| 13 | | + | + | | | | | | | | | | | | | | | | | |
| 12 | | + | — | | | | | | | | | | | | | | | | | |
| 11 | + | — | — | | | | | | | | | | | | | | | | | |
| 10 | — | | — | | | | | | | | | | | | | | | | | |
| .. | | | | | | | | | | | | | | | | | | | | |
| 5 | — | | | | | | | | | | | | | | | | | | | |
| $X =$ | 10.5 | 11.5 | 12.5 | | | | | | | | | | | | | | | | | |

(+ = 2-pt report)
(— = 1-pt report)

STATISTICAL TREATMENT :

Let $M$ = Mean ; $X$ = Limen-estimate ; $N$ = Number of Limen-estimates ; $x$ = deviation from the mean $= X - M$.

(*i*) *Mean* of Limen for all series : $M = \Sigma X/N$.

(*ii*) Standard Deviation : $\sigma = \sqrt{\Sigma x^2/N}$. (or found with an $AM$ and $c$).

(*iii*) Standard Error of Mean : $\sigma\mathrm{M} = SE\mathrm{M} = \sigma/\sqrt{N-1}$. (or $\sigma/\sqrt{N}$ for samples 30 +)

(*iv*) Critical Ratio in σ-units : $CR\sigma = D/\sigma\text{diff}$

$$\sigma\text{diff} = \sqrt{\sigma\mathrm{M}^2_1 + \sigma\mathrm{M}^2_2}$$

We will use *sub-scripts* $a$, for ascending series, $d$ for descending series ; and 1 for the first half, and 2 for the second half.

Find the $M_d$, $M_a$, $M_1$ and $M_2$ ; also σ and σM for each of them. Determine the significance of the differences between $M_a$ and $M_d$ ; and between $M_1$ and $M_2$.

(*Level of Sig.* or $CR\sigma$ : 1.96 = 5 per cent ; 2.58 = 1 per cent ; 3.00 = .1 per cent).

If $Ma$ is higher, it shows 'habituation' error is greater than the 'expectation' error, and *vice versa*. If $M_1$ is higher, then it shows that 'learning effect' is greater than the 'fatigue effect'.

The final *results* may be tabulated as follows :

| | *Total** | *a-series* | *d-series* | *1st half* | *2nd half* |
|---|---|---|---|---|---|
| Mean | | | | | |
| σ | | | | | |
| σM | | | | | |
| | D | $(M_a - M_d)$ | | $(M_2 - M_1)$ | |
| | σdiff | | | | |
| | Significance | | | | |

---

* When $N_1 = N_2$, then $M_t = \dfrac{M_1 + M_2}{2}$ and

$$\sigma_t = \sqrt{\tfrac{1}{2}(M_1^2 + \sigma_1^2 + M_2^2 + \sigma_2^2) - M_t^2}$$

*Movement error :* $e_m = \frac{1}{2} \mid M_a - M_d \mid$.

The $RL$ or Stimulus Threshold is obtained from the column for *Total.* (Sometimes it is useful to obtain $PE = .6745\sigma$. The result is written as $M \pm PE$)

### COMMENT AND REMARKS

*Note* 1 : The experiment proper can also be performed with the design : *d, a, d, a, d ;* rest, *a, d, a, d, a ;* rest, etc. The first descending series will begin with $S_v$ = the maximum 2-pt report of the practice experiment range.

*Note* 2 : If 40 or 60, or even more observations of the Limen-estimate are taken ; then the influence of *practice* (or learning) and *fatigue* may be measured by comparing the average of any 10 series, with that of any later set of 10 series.

*Note* 3 : The influence of the *initial a* or *d-series,* can also be compared by taking in the above example, the $M$ of the sum of the 1st 5 series and the 3rd set of 5 estimates $(I + III)$ ; and comparing it with the $M$ of the *sum* of the 2nd and 4th set of estimates $(II + IV)$.

*Note* 4 : In this method of *serial exploration* by minimal graded limits, each *a*-estimate is immediately followed by a *d*-estimate ; while in the method of *mean error* or equivalents, generally an *a*-series estimate is followed by other *a*-series estimates; and similarly the series of *d* observations are also repeated, as in experiment 1.

In each series of these observations, the $S_v$ is changed by a *constant* amount ; while in the *Mean Error* procedure, the $S_v$ is changed continuously to an equivalent position.

*Note* 5 : Some experimenters are not interested in the Error of Movement $(e_m)$; so they adopt the practice of combining each pair of *a*, *d* (or *da*) series, and thus obtain a *mean stimulus limen* value for each pair : $\frac{1}{2}(L_a + L_d)$. These stimulus limen $(RL)$ values are averaged, and a $SD$ is also calculated. (Woodworth calls the mean stimulus limen or $RL$, as Average Threshold, *AvT*. *Vide*, p. 398).

*Note* 6 : This is the most direct method for the determination of the stimulus threshold (or $RL$). But, if the $O$ is inclined to give some *equal* or *uncertain* (?) judgments in the course of his comparative observations, then this direct method can also be used for measuring a *difference threshold* (or $DL$).

## EXPERIMENT 29

### PROBLEM

To determine the *DL* for a given brightness.

*Method and Stat. Tech.:* Method of *Serial Exploration* with 3-category responses. Also called 'method of limits, or minimal changes with *complete knowledge*' (Müller). Calculation of the *Point of Subjective Equality* (*PSE*); and analysis of variance.

### MATERIALS

A colour-mixer ; White and black discs of two sizes, dia. 6″ and 10″ ; a protractor ; screen with an exposure window, 1″ × 2″.

The large White, and Black discs are combined together with a black sector as $100°B + 260°W$. The smaller pair of discs are mounted above them, on the same colour-wheel and in the same ratio.

### PROCEDURE

*O* knows that $S_v$ is increasing or decreasing. Both $S_v$ and $S_s$ are presented, after obtaining fusion by an adequate speed of rotation, to *O* through the exposure window of the screen, which is placed alongside a radius. When the $S_v$ is the outer circle, the *space* condition is 'variable outer' (*VO*); and when $S_v$ is inner then the condition is 'variable inner' (*VI*).

The position of the base of the colour-wheel should be marked on the table. If the base is circular, then the location of the lever at *Off* should also be marked. After each observation, the $S_v$ is increased (or decreased) by 4°. (The amount of variation by an odd number of degrees will complicate later calculations). This may need a movement of the colour-wheel, screen, etc. and later their replacement on the *marked* positions.*

*E* should say 'ready', a couple of seconds before the 1″ exposure of the stimuli for comparison. Each *a*-series is followed by a *d*-series and *vice versa*. One series of observations yields only *one* difference limen-estimate.

---

* This can be avoided only when the laboratory has a very costly *colour comparator* apparatus.

$O$ is instructed to report the $S_v$ as equal (=), or brighter (+), or darker (−). Doubtful judgments are included in the equal category. In each series the observation should begin with $S_v = S_s \pm 10$ steps or so. The $S_v$ is continued to vary from the original reports (+) through equal (=) to the opposite report (−). (Some suggest getting 2 consecutive opposite reports.) Thus we get two *limits*, one +, and one −.

*Practice Experiment:* For practice, take 2 estimations with *VO*, and 2 estimations with *VI* conditions.

(Suggestion for a simple experimental design : (*VO*) *a*, *d*, *a*, *d*, *a*, *d*, rest ; (*VI*) *d*, *a*, *d*, *a*, *d*, *a*, rest ; (*VI*) *a*, *d*, *a*, *d*, *a*, *d*, rest ; (*VO*) *d*, *a*, *d*, *a*, *d*, *a*.

RESULTS

Record sheet for judgments of *DL* for brightness. Standard was a rotating disc : 260°*W* + 100°*B*.

| | | | *VO* | | | | *VI* | *VI* | *VO* | *Code for* |
|---|---|---|---|---|---|---|---|---|---|---|
| **$S_v$ order* | *a* | *d* | *a* | *d* | *a* | *d.* | *a—d* | *a—d* | *a—d* | *PSE* |
| 296 | | | | | | | | | | |
| 292 | | | | + | | | | | | |
| .. | | | | | | | | | | |
| *280* | | + | | + | | | | | | |
| 276 | | + | | + | | | | | | 10 |
| 272 | + | + | | = | | | | | | 8 |
| 268 | = | = | + | = | + | | | | | 6 |
| 264 | = | = | = | = | = | | | | | 4 |
| 260 | = | = | = | = | = | | | | | 2 |
| *256* | = | — | = | = | = | | | | | 0 |
| 252 | — | — | = | — | = | | | | | − 2 |
| 248 | — | — | — | | — | | | | | − 4 |
| 244 | — | | — | | — | | | | | |
| .. | | | | | | | | | | |
| *220* | — | | | | | | | | | |
| *2DL* | 4 | 3 | 4 | 5 | 4 | | | | | |
| *PSE* | 5 | 6 | 3 | 6 | 3 | | | | | |

(*$S_v$ in degree of *W* only). [$2DL$ = Number of *equal* judgments. $PSE = \frac{1}{2}(U + L)$, in terms of coded values.]

The calculations of $2DL$ and $PSE$ are much simplified by using a Code for $PSE$. It should be noted that $DL$ is found by $\frac{1}{2}(iM')$, where $M'$ is the mean $2DL$, and $i =$ the $S_v$ interval (here 4°). (The mean from grouped data is described by $M'$).

The $DL$ values can be treated in a *two-way design* for analysis of variance to determine the significance of the *series-order* variation, and the space-arrangement.

In one case, the $DL$ data was as follows :

| *VO* | | *VI* | |
|---|---|---|---|
| *a* | *d* | *a* | *d* |
| 3 | 1 | 2 | 1 |
| 4 | 2 | 2 | 1 |
| 3 | 1 | 1 | 2 |
| 3 | 2 | 2 | 3 |
| 3 | 4 | 1 | 2 |
| 2 | 2 | 1 | 2 |

And the $\Sigma x$ and $\Sigma x^2$ are arranged as :

| | *a* | $a^2$ | *d* | $d^2$ | $\Sigma x$ | $\Sigma x^2$ |
|---|---|---|---|---|---|---|
| *VO* | 18 | | 12 | | 30 | |
| | | 56 | | 30 | | 86 |
| *VI* | 9 | | 11 | | 20 | |
| | | 25 | | 23 | | 48 |
| $\Sigma x$ | 27 | | 23 | | 50 | |
| $\Sigma x^2$ | | 81 | | 53 | | 134 |

$$\Sigma x^2_t = 134 - 50^2/24 = 134 - 104.17 = 29.23 \quad (C = 104.17)$$

$$\Sigma d^2_{rk} = \frac{18^2 + 9^2 + 12^2 + 11^2}{6} - 104.17 = \frac{670 - 625 = 7.5}{6}$$

$$\Sigma d^2_r = \frac{30^2 + 20^2}{12} - 104.17 = \frac{900 + 400 - 1250}{12} = 4.17$$

$$\Sigma d^2_k = \frac{27^2 + 23^2}{12} - C = \frac{729 + 529 - 1250}{12} = 0.67$$

$$\Sigma d^2(_{r \times k}) = 7.5 - 4.17 - 0.67 = 2.66$$

$$\Sigma x^2_s \doteq 29.23 - 7.5 = 21.73$$

TABLE 8

SUMMARY OF ESTIMATES OF VARIANCE AND F-RATIOS

| *Source* | $\Sigma sq$ | *df* | *V* | *F* | *Significance* |
|---|---|---|---|---|---|
| Space (*s*) | 4.17 | 1 | 4.17 | 3.8 | $p<4.35$ at .05 level |
| Movement (*m*) | 0.67 | 1 | 0.67 | 0.6 | $p< .05$ |
| Interaction ($s \times m$) | 2.66 | 1 | 2.67 | 2.4 | $p< .05$ |
| Within Sets | 21.73 | 20 | 1.09 | | |

All $F$ ratios are insignificant. So we conclude that so far as the $DL$ estimates are concerned, the errors of habituation and expectation ($M_a$ and $M_d$) have balanced out, and the space-arrangement ($VO$ and $VI$) makes no real difference to the size of $DL$. In other words, the data for $a$ and $d$, as well as for $O$ and $I$ series is homogeneous. Thus we can pool the data, and tabulate them as in Experiment 1 ; and find the values of $M_j$ ; $e_m$ ; $e_s$ ; $DL$ and $PSE$.

Determine the Weber Ratio : $DL/S_s$.

*Note* 1 : It is also possible to use the formula : $DL/PSE$ (or $\triangle S/S$).

*Note* 2 : As the black paper of the sector does not reflect zero light, it would be proper to determine by a *photometer*, how much light the black does reflect relative to the White. Guilford suggests that the ratio 25 to 1 for reflections from White and Black papers is a safe assumption. Thus the grey of any $S = B + 25W$. But as $B = 360° - W$ ; so we have, $S = 360 - W + 25W = 360 + 24W$.

Thus we can determine the value of $PSE$ in photometric units (as $x$ units) and also find out the value of $PSE + DL$ in photometric units (as $y$ units), by the above-said formula. Then $\triangle S/S = (y - x)/x$. This is to be further converted into a per cent ratio, indicating the difference in brightness at the given level of the standard stimulus.

*Note* 3 : Perform the same experiment with $S_s$ equal to (*i*) $180W + 180B$ ; (*ii*) $90W + 270B$ ; and compare the Weber-ratios obtained.

*Note* 4 : A similar experiment could be performed with a given hue-mixture as the standard stimulus.

*Note* 5 : Before calculating $PSE$, we may also treat the $PSE$ data with the procedure for analysis of variance.

*Note* 6 : The $O$ has to give some *equal* judgments to obtain a genuine $DL$ by this method ; as we must get an 'interval of uncertainty'. ($DL = \frac{1}{2}IU$).

*Note* 7 : Since $O$ knows the arrangement of the stimuli, it is the method with *complete knowledge*.

## EXPERIMENT 30

### PROBLEM

Determine the $DL$ for lifted weights.

*Method and Statistical Technique :* Method of *constant stimuli* with 3-category response. Calculation by Spearman's *summation* and checked by *distribution method.*

### MATERIALS

A set of 11 wooden tubes : One $S_s = 50$ gms ; and others as $S_v$, weighted with 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, and 55 gms ; a screen ; blind goggles ; cloth pad ; a chart for haphazard presentation of $S_v$.

### PROCEDURE

In general as in Experiment 26, but the $O$ is explicitly instructed to report stimuli presented *second*, as lighter (or lesser), equal, or greater than the stimulus presented *first*. Thus for each $S_v$, there is the possibility of some $L$, $E$, and $G$ judgments.

The $L$ and $G$ for $S_s$-$II$ is reversed for final calculation.

*Practice Experiment :* Take some 20 observations, in the *time* conditions of Standard first, and in Standard second.

### RESULTS

*Records* are obtained and analysed for both time conditions. In one case the proportions for *total* judgments were as shown in the top Table on next page.

Since $S_v$ with $p = 1.00$ $G$-judgments, is the higher variable, we use formula (*i*), in Experiment 26, Note 3. And for $L$-judgments, we will use (*ii*).

$M_h = 55 - .5 - 1 \times 4.40 = 55 - 4.90 = 50.10$ gms. and
$M_l = 44 + .5 + 1 \times 4.30 = 44 + 4.80 = 48.80$ gms.
$DL = (M_h - M_l)/2 = (50.10 - 48.80)/2 = 1.30/2 = 0.65$ gms.
$SD_h = \sqrt{2 \times 16.50 - (4.40)^2 - 4.40} = 3.04$ ; and $SD_l = 3.23$ ; $A_v\ SD = (SD_h + SD_l)/2 = (3.04 + 3.23)/2 = 6.27/2 = 3.135$ or 3.14.

Weber's Ratio $= DL/S_s = 0.65/50 = .013$ or 1.3 per cent.
$PSE = (M_h + M_l)/2 = (50.10 + 48.80)/2 = 49.45$ gms.
$CE = PSE - S_s = 49.45 - 50 = - 0.55$ gms.

| $S_v$ | $G$ | | $E$ | $L$ | | Remarks |
|---|---|---|---|---|---|---|
| | $p$ | $p'$ | $p$ | $p$ | $p'$ | |
| 45 gm | 0 | | .10 | .90 | 4.30 | For Lighter, 44 gm *assumed* to give 1.00 |
| 46 ,, | .10 | .10 | .30 | .60 | 3.40 | |
| 47 ,, | .30 | .40 | .10 | .60 | 2.80 | |
| 48 ,, | .10 | .50 | .10 | .80 | 2.20 | |
| 49 ,, | .30 | .80 | .20 | .50 | 1.40 | |
| 50 ,, | .90 | 1.70 | .00 | .10 | .90 | |
| 51 ,, | .50 | 2.20 | .20 | .30 | .80 | |
| 52 ,, | .70 | 2.90 | .00 | .30 | .50 | |
| 53 ,, | .60 | 3.50 | .30 | .10 | .20 | For $G$, 55 gms assumed to give 1.00 |
| 54 ,, | .90 | 4.40 | .00 | .10 | .10 | |
| 55 ,, | (1.00) | | | .00 | | |
| $\Sigma =$ | 4.40 | 16.50 | 1.30 | 4.30 | 16.60 | |

Data by V. Goel.

*Note* 1*:* We can also find $DL$ by the formula, $DL = \frac{1}{2}(i.E) = \frac{1}{2}(1 \times 1.30) = 0.65$ gms.

*Note* 2*:* The above data can also be computed by the *distribution* method, in which an ordinary distribution of the transition points is obtained by *subtraction* of adjacent proportions from 0.0 to 1.0. Such a distribution appears more familiar to some $E_s$. We will illustrate by $G$-data :

| $S_v$ | $p$ | $AS_v$ | $f'$ | $d$ | $f'd$ | $f'd^2$ |
|---|---|---|---|---|---|---|
| 45 | 0.0 | 45.5 | .10 | $-5$ | $-$ .50 | 2.50 |
| 46 | .10 | 46.5 | .20 | $-4$ | $-$ .80 | 3.20 |
| 47 | .30 | 47.5 | $-$.20 | $-3$ | $+$ .60 | $-$ 1.80 |
| 48 | .10 | 48.5 | .20 | $-2$ | $-$ .40 | .80 |
| 49 | .30 | 49.5 | .60 | $-1$ | $-$ .60 | .60 |
| 50 | .90 | 50.5 | $-$.40 | 0 | (Assumed Mean) | |
| 51 | .50 | 51.5 | .20 | $+1$ | .20 | .20 |
| 52 | .70 | 52.5 | $-$.10 | $+2$ | $-$ .20 | $-$ .40 |
| 53 | .60 | 53.5 | .30 | $+3$ | .90 | 2.70 |
| 54 | .90 | 54.5 | .10 | $+4$ | .40 | 1.60 |
| 55 | (1.00) | | | | | |
| | | | $\Sigma = (1.00)$ | | $+2.10$<br>$-2.50$ | $+11.60$<br>$+$ 2.20 |
| | | | | | $-0.40$ | $-$ 9.40 |

$N = \Sigma f'$ ; $AS_v$ = Assumed $S_v$ ;
$i = 1$ gm ; Therefore $ci = (-\ 0.40) \times 1$. $M = AM + ci$ $= 50.5 - 0.40 = 50.10$ gm ; and $SD = i\sqrt{\Sigma f'\ d^2/N - c^2}$ $= 1 \times \sqrt{9.40 - .16} = 3.04$ gms.

These values are identical with those obtained earlier by the summation method. This method was also suggested by Prof. Spearman. However, one has to be very *careful* about reversals of judgments by $O$. These are calculated as *negative* changes of proportions. And these negative signs are continued in later calculations of $f'd$ and $f'd^2$.

## EXPERIMENT 31

PROBLEM

Determine an *equivalent* extent for a given visual extent.

*Method and Statistical Technique:* Method of paired-comparison, with constant stimuli, or graded limits: 3-category response. Use of a *chance* (or *haphazard*) *order* of presentation.

MATERIALS

Jalota's paired-comparison tachistoscope; a set of cards with a *Feather-head* standard, line $= 2''$; $<\phi = 45°$, and arms $= \frac{1}{2}''$; and 6 *Arrow-head* variables of 2.0, 2.1, 2.2, 2.3, 2.4 and 2.5″ respectively.

(*i*) Jalota's paired-comparison gravity tachistoscope* is a simple apparatus, in which the *O* is faced with a grey wooden screen unfolded before him. In the centre is a sliding window with *a thin dark cross in its centre*. When *E* signals 'ready', *O* is to fixate the said cross. *E* sits behind the screen, and arranges the display of the $S_s$ and $S_v$, by placing them through the guide-bar and the guide-rail provided at the bottom and the top of the exposure window. *E* can simultaneously expose the pair of stimuli for comparison, by turning a knob through an angle of about 90°. The exposure can be terminated by releasing the knob, and the small wooden sliding screen falls back upon rubber cushions, that are useful for reducing noise. This tachistoscope is useful only for relatively long exposures. (A short exposure is less than 1/200″, and does not permit eye-movement, or *two* glances by *O*). Usually the stimuli are exposed for 1 second nearly.

(*ii*) A *chance* order for the presentation of stimuli can be prepared in this case, by taking a pack of playing cards, and removing the 4 kings. This will leave us with 48 cards; and we have 6 variables. So each of these cards is assigned a number of the variables, *e.g.*

| *Card* | *A* | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | *J* | *Q* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $S_v$ | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |

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* Reported in *Proc. Psychol. & Educ. Sec., 39th Session Ind. Sc. Cong.*, 1952, III, 277.

The pack is thoroughly shuffled. It may be cut and dealt one by one, each face upwards. The order of cards thus obtained, is taken to represent the serial order for the *chance* presentation of the given variables. (In the chance order of presentation, it is possible that any $S_v$ may be repeated ; also that some stimuli may be in consecutive order).

(*iii*) The figures are drawn in the middle of each card ; but they are so placed that one end-point of the *arrow-head* figures is within $\frac{1}{4}$ to $\frac{1}{2}''$ of one side of the given card. In the case of the *feather-head* figures, one pair of arms of the feather-head should be nearer to one side. So that when the cards are presented together for comparison, the $FH$ and $AH$ are separated by only some 1″ or so.

PROCEDURE

Half the observations (10 each) are taken in the space-condition Standard Right ($S_sR$), and the other half in the condition Standard Left ($S_sL$).

*Instructions :* "When I say 'ready', attend to the centre of this cross on the screen of the tachistoscope (point to the centre). When the figures are exposed, give your judgment about the Arrow-head figure on your *right* (or left), as lesser, greater or equal than the standard Feather-head figure."

*Practice Experiment :* Take some 24 readings. $E$ will thus be able to improve the technique of presenting the $S_v$, and also for recording the responses.

RESULTS

The results are analysed and tabulated for the different variables, and for each of the space-conditions, $R$ and $L$.

*Mean limens* (50 per cent judgment transition points) are calculated for the shorter (or $L$) and for the longer (or Greater, $G$) judgments ; also $SD_s$.

Find $PSE$ for $S_sR$, and for $S_sL$ conditions.

Also, find out $e_s$, and $CR_\sigma$ for the $R$ and $L$ conditions.

Determine the $PSE$ for the *total* observations. This should be done by pooling together all the $S_sR$ and $S_sL$ observations. ($DL$ may be taken to indicate the *precision* of the given $O$).

(Some experimenters prefer to obtain an estimation of the *Standard Error of the Mean* ($SE_m$): $SE_m = \sigma / \sqrt{N-1}$. But in this case, $N$ = the number of times all variables are judged, *e.g.* each judged 10 times $R$, and equally often $L$; and 6 variables. Therefore $N = 6 \times 10 \times 2 = 120$).

*Note* 1: Estimate values for the same distance between featherheads, but with angles of 15, 30, 60 and 90 degrees.

*Note* 2: Let the *standard* be an arrow-head figure 3″; and $S_v$ be *FH* 2.1″, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 and 2.9 inches. Obtain equivalent values, and compare them with other results.

*Note* 3: At least *one* other comparative estimate must be obtained.

*Note* 4: Try to discover, whether the space condition has a similar influence upon the *shorter* and the *longer* judgments.

## EXPERIMENT 32

PROBLEM

To determine the order of aesthetic preference for a given set of colours.

*Method and Statistical Technique:* Method of impression : paired comparison. Scaling by the *composite-standard* technique.

MATERIALS

Jalota's paired-comparison tachistoscope ; a set of cards with strips of various coloured papers 2″ × 1″, pasted in the centre near one edge ; an order of presentation for the variables ; paper with wide squares for recording purposes.

PROCEDURE

(*i*) The exposure should be for 1 to 2 seconds. *O* has to give a "forced choice" between the comparison-pair ; in other words *O* cannot say "doubtful", or "neither".

*Instructions:* "When I say 'ready', attend to the centre of the cross on the screen of the tachistoscope. When the pair of colours are exposed, speak out your preference (for the right hand colour ; or give the name of the preferred colour)."

(*ii*) Each colour is to be compared with every other, in both the *R* and *L* space arrangements. Although recording can be done on one table ; it is more convenient and less liable to error, if the results for the *R*, and *L* sets are put in two separate stair-case type recording tables.

Tables 9A and 9B are indicating *preferred* colour by its initial at intersection.

We know that *Average Preference* = AvP $= \frac{1}{2}(\mathrm{N} - 1) = \frac{1}{2}(7 - 1) = 3$.

If $n$ be the number of sets of observations in *each* space arrangement, and $N$ be the number of items (colours); then $AvP^2$ is obtained by the formula : $AvP^2 = \Sigma P^2/(2n)^2 \times N = 312/2^2 \times 7 = 312/28 = 11.14$.

*SD* of Preference $= SD_P = \sqrt{AvP^2 - (AvP)^2} = \sqrt{11.14 - 3^2} = \sqrt{2.14} = 1.463$

### TABLE 9A AND 9B

### PREFERRED COLOUR BY ITS INITIAL AT INTERSECTION

| (*A*) *Comparison Colour* | *Compared Colour L (of O)* | | | | | | | *Row Total* |
|---|---|---|---|---|---|---|---|---|
| | *M* | *Bl* | *O* | *V* | *G* | *P* | *Y* | |
| Maroon (*M*) | | | | | | | | 0 |
| Blue (*Bl*) | *M* | | | | | | | 0 |
| Orange (*O*) | *O* | *O* | | | | | | 2 |
| Violet (*V*) | *V* | *V* | *O* | | | | | 2 |
| Green (*G*) | *M* | *Bl* | *G* | *V* | | | | 1 |
| Pink (*P*) | *M* | *P* | *O* | *P* | *G* | | | 2 |
| Yellow (*Y*) | *M* | *Y* | *O* | *V* | *G* | *Y* | | 2 |
| Preferences | 4 | 1 | 3 | 2 | 2 | 0 | 0 | |

| (*B*) *Comparison Colour* | *Compared Colour R* | | | | | | | *Row Total* |
|---|---|---|---|---|---|---|---|---|
| | *M* | *Bl* | *O* | *V* | *G* | *P* | *Y* | |
| Maroon (*M*) | | *M* | *O* | *V* | *G* | *M* | *Y* | 2 |
| Blue (*Bl*) | | | *O* | *V* | *G* | *P* | *Y* | 0 |
| Orange (*O*) | | | | *O* | *O* | *O* | *O* | 4 |
| Violet (*V*) | | | | | *G* | *V* | *V* | 2 |
| Green (*G*) | | | | | | *P* | *G* | 1 |
| Pink (*P*) | | | | | | | *Y* | 0 |
| Yellow (*Y*) | | | | | | | | 0 |
| Preferences | 0 | 0 | 2 | 2 | 3 | 2 | 3 | |

Data of M. Sood.

The results may be finally summarised as in Table 10:

### TABLE 10

### SUMMARY OF TOTAL PREFERENCES

| *Colour* | *M* | *Bl* | *O* | *V* | *G* | *P* | *Y* | *Total check*† | ($n$) |
|---|---|---|---|---|---|---|---|---|---|
| *$P(L)$ | 4 | 1 | 5 | 4 | 3 | 2 | 2 | 21 | 1 |
| *$P(R)$ | 2 | 0 | 6 | 4 | 4 | 2 | 3 | 21 | 1 |
| Total $P$: | 6 | 1 | 11 | 8 | 7 | 4 | 5 | 42 | 2 |
| $P^2$: | 36 | 1 | 121 | 64 | 49 | 16 | 25 | 312 | |

*Sum of *row* and *column* totals. †Checked by the formula $^nC_2 = \frac{n(n-1)}{2}$.

$SD_N = (\sqrt{(N^2 - 1)/12} = \sqrt{48/12} = 2.00$
$\therefore$ precision $= t = SD_P/SD_N = 1.46/2.00 = .73$.
Hence, we know that the order of preference is *O V G M Y P B L* in a decreasing order ; and that the precision of *O* is .73.

*Note* 1 : (A complex illustration).
In one case, the final data from 5 sets of observations in *each* space condition for 8 items, was as follows :

| | *Bl* | *BlG* | *P* | *R* | *Y* | *V* | *Br* | *G* | *Total* |
|---|---|---|---|---|---|---|---|---|---|
| *P* | 38 | 61 | 40 | 27 | 48 | 11 | 42 | 13 | |
| $P^2$ | 1444 | 3721 | 1600 | 729 | 2304 | 121 | 1764 | 169 | 11852 |

Data of S. R. Gupta.

The preference may be arranged in an *ascending order of preference :*

| Colour : | *V* | *C* | *R* | *Bl* | *P* | *Br* | *Y* | *BlG* |
|---|---|---|---|---|---|---|---|---|
| Preference : | 11 | 13 | 27 | 38 | 40 | 42 | 48 | 61 |

$\therefore$ (*i*) $AvP = \frac{1}{2}(N-1) = \frac{1}{2} \times 7 = 3.5$
(*ii*) $AvP^2 = \Sigma P^2/(2n)^2 . N = 11852/10^2 \times 8 = 14.815$
(*iii*) $SD_P = \sqrt{AvP^2 - (AvP^2)} = \sqrt{(14.815) - (3.5^2)} = 1.60$
(*iv*) $SD_N = \sqrt{(N^2 - 1)/12)} = \sqrt{(64 - 1)/12} = 2.29$
(*v*) $t = SD_P/SD_N = 1.60/2.29 = 0.69$.

The order of preference is *BlG*, *Y*, *Br*, *P*, *Bl*, *R*, *G* and *V* for this observer ; and his precision of judgment is .69.

*Note* 2 : This method can also be used in a large number of social situations, etc. *e.g.* preference for Bengali *vs* Punjabi ; Cabbage *vs* Brinjals, etc. ; preferences among simple rectangular forms, etc. In all such cases the observations from paired-comparisons can be transformed into a *scale of preference*. A simple technique of the *composite standard method* is suggested by Guilford (p. 170). Although it is best employed, where a large number of observations are available, say 100 times each paired-comparison or so, yet there is no harm in illustrating the technique with reference to the *data* in the earlier *Note* 1. We draw a Table as follows :

### TABLE 11

### AVERAGE PROPORTIONS OF PREFERENCE FOR COLOURS ARRANGED IN AN ASCENDING ORDER OF PREFERENCE

| *Colour* | (1)*V* | (2)*G* | (3)*R* | (4)*Bl* | (5)*P* | (6)*Br* | (7)*Y* | (8)*BlG* |
|---|---|---|---|---|---|---|---|---|
| $\Sigma p$ | 1.1 | 1.3 | 2.7 | 3.8 | 4.0 | 4.2 | .8 | 6.1 |
| $Mp$ | .14 | .16 | .34 | .48 | .50 | .53 | .60 | .76 |
| $Zj$ | −1.080 | −.994 | −.412 | −.050 | 0.000 | +.075 | +.253 | +.706 |
| $Rj$ | .000 | .086 | .668 | 1.030 | 1.080 | 1.155 | 1.333 | 1.786 |
| $Rc$* | −.39 | −.09 | 1.95 | 3.22 | 3.39 | 3.65 | 4.28 | 5.87 |

Data from *Note* 1.

[ * $Rc = 3.502\,(Zj + .969) = 3.502\,Rj - .388$.

$\Sigma p$ = Sum of proportions of preferences (favourable).

$Mp$ = Mean proportion = $\Sigma p/N$

$Zj$ = Normal Deviate value

$Rj$ = Scale distance, when Minimum $Zj = 0.0$

$Rc$ = Corrected scale values from a *meaningful* zero point.]

| † $Zj$ | $Zj^2$ | $Rj$ | $Rj^2$ |
|---|---|---|---|
| −1.080 | 1.166 | .000 | .000 |
| − .994 | .988 | .086 | .007 |
| − .412 | .170 | .668 | .446 |
| − .050 | .002 | 1.030 | 1.060 |
| .000 | .000 | 1.080 | 1.166 |
| + .075 | .006 | 1.155 | 1.334 |
| + .253 | .064 | 1.333 | 1.777 |
| + .706 | .498 | 1.786 | 3.190 |
| −2.536 | | | |
| +1.034 | 2.894 | 7.048 | 8.980 |
| −1.502 | | | |

† (*Computation of* $\sigma_{ZJ}$, $\sigma_{RJ}$ and $Rc$).

To obtain *Rc*, we have to first find *SD* for *Zj*, as well as for *Rj*, as follows :

We know that $\sigma x = 1/N \times \sqrt{N\Sigma x^2 - (\Sigma x)^2}$;

$$\therefore \quad \sigma_{ZJ} = (1/8)\sqrt{8 \times 2.894 - (-1.502)^2}$$
$$= (1/8)\sqrt{23.152 - 2.255};$$
$$= (1/8)\sqrt{20.897} = (1/8)(4.571);$$
$$= .571$$
$$\therefore \quad \sigma_{RJ} = (1/8)\sqrt{8 \times 8.980 - (7.048)^2};$$
$$= (1/8)\sqrt{71.840 - 49.67};$$
$$= (1/8)\sqrt{22.17} = (1/8)(4.708)$$
$$= .589$$

$\therefore$ the *regression coefficient* $\sigma zj/\sigma Rj = .571/.589 = .969$.
Also, the *multiplier* for a scale with $\sigma = 2$, will be $2/.571 = 3.502$.
$\therefore Rc = 3.502\ (Zj + .969)$. But $Zj = Rj - 1.080$.
$\therefore Rc = 3.502\ (Rj - 1.080 + .969) = 3.502Rj - .388$.

We find that, Violet and Green have a negative value. All this situation can be graphically described by drawing a scale, and indicating the preferred colours on that.

*Note* 3 : The judgments of *ranking*, or of *rating* by a large group of persons can also be pooled, and the average preferences for the set calculated. These values can be readily scaled by the method of the composite standard mentioned above.

*Note* 4 : It is held convenient for a *standard scale* to have a meaningful or psychological Zero-point, and also a common Standard Deviation. Hence, each scale is transformed for comparative convenience into a standard scale with a *SD* equal to 2.

## EXPERIMENT 33

### Problem

To determine the influence of attention to a mental task upon respiration.

*Method and Statistical Technique :* Method of *expression*. Calculation of the respiration fraction.

### Materials

Kymograph ; pneumograph ; rubber tubing ; Marey's Tambour ; spring time marker ; practice problems ; glazed paper for kymograph record ; smoking burner ; smoking stand ; screen ; Jalota's paired-comparison tachistoscope ; varnish solution ; varnishing tray ; clips ; drawing instruments box, specially a pair of dividers, set-squares, and scale ; stop-clock.

(*i*) The *kymograph* is an apparatus mainly consisting of a rotating drum. The drum-surface is covered with a glazed paper, which is usually coated with smoke. The drum is rotated by means of an electric motor (or a spring motor), at a speed controlled by a suitable arrangement of pulleys and belting, or gears, etc. The record of movements by *O* is obtained by suitable lever-pointers, connected with the paper on the drum, and indicating by up and down strokes, some aspect of the *O*'s response, or his movements. The kymograph usually rotates in a *clock-wise* direction.

(*ii*) The *pneumograph* is an apparatus which indicates by the rise and fall of a *tambour* lever, the situation of inspiration and expiration during the respiration cycle. The lever is placed in contact with the smoked paper upon the kymograph. The pneumograph essentially consists of a long tube (sometimes elastic), with a connecting metal tube or tubular point. There is also a chain, or ribbon to bind the pneumograph round *O*'s body ; and another ribbon to go round the neck, and thus keep the pneumograph at a definite distance from the neck.

(*iii*) The Marey's *tambour* is a hollow cup with a connecting metal tube. The cup is covered with a thin elastic rubber, stretched and tied air-tight. The metal tube-end of the tambour is connected by means of a suitable length of rubber tubing with the metal tube-end of the pneumograph.

(*iv*) The glazed paper is evenly spread upon the drum, and clamped or glued upon the drum. The *inner* end of this paper points in the clock-wise direction, and hence the upper overlapping end points in the opposite direction.

(*v*) The *smoking burner* gives a broad flame. It should be held near to the paper-covered drum, so that the coat of smoke is laid upon the glazed paper surface. The drum is gently rotated on the smoking stand, and a thin coat of smoke is evenly spread over the glazed paper.

(*vi*) The *tachistoscope* is used for exposing the mental tasks. During *practice*, a number of mental tasks or problems are used to determine the length of one likely to take about 30 seconds.

(*vii*) The *spring time marker* is adjusted by sliding the weight to the position giving ½″ oscillations. The record for 20 seconds may be scrutinized, and the correction determined, if any. When the kymograph is moving at a fast speed, then the time-marker may be adjusted to give 1/5 second oscillations.

(*viii*) When the record is completed, the smoked paper is *carefully* removed from the kymograph. Now it is called a *kymogram*. Necessary *legends* are written with the dry nib of an ordinary pen, *e.g.* name of subject, speed of the rotating drum, the time-constant for the time-marker, date, time, etc. Then a clip is attached to each length-wise end of the kymogram. Varnish is poured into the tray, and one end of the kymogram is gently dipped (¼″ to ½″) into the solution. The end is gently pulled out, and thus the whole record is passed through the solution. One dip, and the passage of the 20″ length in 5 to 8 seconds through the varnish solution, is enough to give a thin coat of varnish. Extra varnish is strained off by holding the kymogram length-wise by one clip and let it hang straight down, while the other clip is lightly touching the tray edge. The clip is usually attached to a hook or hanger, for a few minutes to dry off the wet varnish coat. On drying, we get a fairly permanent record of *O*'s responses, and can safely handle it for obtaining further detailed measurements.

(*ix*) A pencil line may be drawn in parallel with the base of the respiration curve, and near to it. Then the pair of set-squares will help us to easily mark off the points for the beginning, and the ending of the *inspiration*, by projecting perpendiculars on the line. These distances can be measured by means of the pair of dividers and the scale. These distances are converted into *times*, with the aid of the time-marker record. (It is possible to sensitize the time-scale, that is usually in ½″, or in 1/5 seconds, by preparing a small strip on the Vernier-principle, *e.g.* for the ½ second record ; take the distance between 4 oscillations, and divide it into 5 equal parts. Thus we could sensitize the scale to ·1″ from its normal .5″ units).

PROCEDURE

See whether *O* belongs to the *thoracic* or the *abdominal* type. Harness the pneumograph accordingly. After connecting the tambour, see that the tambour diaphragm is fairly stretched. (In the Boulitte type pneumographs, where the apparatus consists of a 1½″ × 2½″ metal tube, with the connecting end ; and a rubber diaphragm with a hook on either side ; if necessary, one may slightly inflate the pneumograph piece, through the rubber tube, before connecting the latter with the tambour). Give some time (about 5 to 10 minutes) for *O* to get adapted to the pneumograph harnessed to his body. In the meantime, expose some *practice problems*, with the *instruction :* "When I say, 'ready', place your right hand on the table, and attend to the cross on the tachistoscope. Solve the problem orally, when it is exposed ; do not talk, nor try to talk ; and when you have finished, indicate by raising your fore-finger (of the hand on the table.)" The time should be noted from a stop-watch (or stop-clock). If the problem is lengthy, it should be shortened ; otherwise it is to be lengthened. A problem of *addition* can be easily modified by varying the number of digits in the columns or rows, or in both. Tasks in addition, of practically equal difficulty, can be readily prepared by having the same number of higher and lower digits in each column for the practice and the experimental problems. The place of the digits in a column, as well as the position of the column is of course to be changed.

Now the *O* is asked to rest for some time (5 to 10 minutes), but the pneumograph is kept harnessed during this period, before starting the experiment proper. Towards the latter part of the rest-interval, the kymograph is started, and a record taken of the 'normal respiration' for some 2 minutes. It should show a fairly regular curve, with quite uniform cycles of inspiration and expiration. If the record is rather irregular, then it is better to take another record after another few minutes, at a slighlty lower level. Having obtained a satisfactory record of 'normal' respiration cycles, start on a fresh level of the kymograph, and after letting the normal record run for some 30 seconds, say 'ready', and in due time expose the problem 'task'. As soon as the *O* signals the solution of the said problem, release the tachistoscope screen, *but continue the pneumographic record* for another 30 seconds or so, to note the *after-effects* of the said task. (If you wish to have records for additional problems, give the *O* rest for 5 to 10 minutes, but the pneumograph is not to be removed).

When recording is not in progress, or not required, the tambour-stand is pulled a little away, to break its lever's contact with the kymograph. The kymograph need not be stopped ; and the time-marker should be adjusted to give a record at the *same* speed of the kymograph. The time record should be taken slightly above or beneath the respiration record. Although only a couple of inches of this time record are essential for later measurements, yet the record looks better when the time record is taken for the entire length of the respiration curve. It would be convenient to have this record midway between the 'normal' and the 'task' respiration records. When the recording is over, unharness the *O*, and ask him for introspective comments.

Remove the kymogram, inscribe the legends, varnish it, and hang it for drying.

## RESULTS

One should inspect and determine for careful measurement, a set of 3 to 5 cycles each, in the early and the later stages of the 'normal' record ; as well as in the pre-task, and the post-task records. The entire period of the *task*-record is also to be carefully measured. Measure the periods of inspiration as accurately as you can, and enter them in the records, serially in one table, as follows :

NORMAL/TASK RECORD

| *Ser. No.* | *Time for* *Insp'n* | *Time for* *Expir'n* | *I-fraction* $[I/(I+E)]$ |
|---|---|---|---|
| 1 | | | |
| 2 | | | |

Calculate the average time for $I$, and for $E$; and determine the $I/(I+E)$ fraction. Find out whether the fraction is increased or decreased during the attentive task.

*Note* 1 : Some experimenters give a psychomotor task like code-substitution. Such tasks require a considerable movement of hands, etc., and these are likely to disturb the respiration cycle of some *O*s too much. If it is so, then such tasks are unsuitable.

*Note* 2 : Some persons prefer to determine the *I/E ratio* (Storring, '06). But its variations occupy a wide range. So we advise its use, if desired, only where the range is limited, say from .5 to 2.0.

*Note* 3 : When the *time*-markings are to be *corrected*, this correction should be applied to the final results. But it will not make any difference to the *I*-fraction, or to the *I*-ratio.

# EXPERIMENT 34

### PROBLEM

To determine the influence of the attitude of attention upon the *speed* of *perceived figure-ground reversals*.

*Method and Statistical Technique:* Method of *impression*. Significance of differences among means.

### MATERIALS

Kymograph; an ambiguous perspective figure (Vase-Faces); Screen; electro-magnetic stylus; commutator; electric battery and connecting wires; a push-key; spring time-marker; stop-clock; a sheet of foolscap paper.

(*i*) The *ambiguous figure* should be about 6″ × 8″ in size. It should be arranged for exposure upon the screen.

(*ii*) The *electro-magnetic stylus* is a lever fitted with a paper (or plastic) indicator, which moves down, or up, as the electric current is switched on, or off, through the electromagnetic circuit. The said circuit is *made* by the initial pressure on the *push*-key; and it is *broken* by the later pressure on the push-key. (Such a push-key gives a better record than the one possible with a spring press-key; as in the latter *O* has to continue the pressure for several seconds, till the break of the circuit is desired. A slight relaxation of pressure is likely to sever contact, and thus disturb the record. But with the push-key, *O* relaxes immediately after each pressure; also each pressure is uniform in character, and *O* gets easily adapted to its use.)

(*iii*) The *commutator* (or reversing key) is an apparatus for reversing the direction of the electric current. The electro-magnetic stylus is connected through this reversing-key with the battery main circuit. After each set of observations (say for a couple of minutes), the current should be reversed to *negate* the effect of *residual magnetism* within the coils of the electro-magnet.

(*iv*) The *stop-clock* (or stop-watch) is an apparatus that measures time in seconds, or smaller units (1/5″, or 1/10″). It can be started, as well as stopped, by moving a lever. The hands of the clock can also be brought to zero (or zero-ised) by pressing another button or lever.

PROCEDURE

(*a*) *E* arranges the apparatus, and tests that the electrical connections are in working order. *O* is seated comfortably, and *instructed:* "When I say 'ready', place your finger on the push-key, and close your eyes. When I say, 'yes', open your eyes and look at the figure before you. Speak out the figure that you see first (Vase, or Faces), and at the same time press the push-key. When this figure shifts, and the *new* figure is clear, press the push-key again. No further speaking is required. In the same way, continue pressing the key after each shift of the perceived figure, until I ask you to 'stop'." *E* makes a note of the 1st perception reported by *O*, and in due course he inscribes it on the kymogram. Thus we obtain one or more records (for 2 to 3 minutes each) during the 'normal' or 'passive' attitude of attention.

(*b*) Now *O* is *instructed anew:* "When I say 'ready', place your finger on the push-key, and close your eyes. When I say, 'now', open your eyes, speak out the first figure that you see, and press the push-key. Now try to *actively shift* the figure into the ground. As soon as the *new* figure is clear, press the push-key; and now try to actively shift the perception of this figure. Again, as soon as the new figure becomes clear, press the push-key, and try to actively shift the perception of this figure, and so on. Continue doing so until I ask you to stop".

(These are the directions for the *facilitating attitude.* But if the *O* is giving fairly quick reversals during the 'normal' response set of observations; then *O* should be instructed to *inhibit:* [that is read after the asterisk] "try *actively to keep on seeing* this figure as long as you can; but when it shifts and the *new* figure becomes clear, press the push-key. And now *try to keep on seeing* this new figure as long as you can. However, when it shifts and the other figure becomes clear, press the signal key, and continue doing so, until I ask you to stop.")

Take one or more records in the *active* attitude (whether facilitating or inhibitory), for about 2 minutes each. Give 2 minutes rest after each record.

Take the time-marker record, and mark two or three intervals of 20 seconds each by the stop-watch. Average the data, and calculate the correction, if any, after the kymogram has been completed and varnished.

Measure the spaces for $F$, and for $V$ responses ; and record them serially for the 'normal' and the 'active' attitudes ; as follows :

| *Ser.* | *Time for normal* | | *Ser.* | *Time for active* | |
|---|---|---|---|---|---|
| *No.* | *F* | *V* | *No.* | *F* | *V* |
| 1 | | | 1 | | |
| 2 | | | 2 | | |
| 3 | | | 3 | | |
| ...etc. | | | ...etc. | | |

For each set of data, find out $M_F$ and $M_V$, as well as $\sigma_F$ and $\sigma_V$ and $SE_M$. Determine the homogeneity of $F$ and $V$ responses by $CR\sigma$ procedure. If the two are homogeneous, combine the data. Otherwise, take the separate statistics for the two sets of data and determine the significance of the attitude of attention upon perception, especially upon the speed of perceived figure-ground reversals.

*Note* 1 : It would be interesting to determine, and try to explain differences in the range, the maximum interval etc. for $F$ and for $V$ responses. Find whether there is a common bias during the *normal* and the *active* attitudes of attention.

*Note* 2 : The *O* should be asked to *stop*, only after the 'break-circuit response', *i.e.* when the electromagnetic stylus springs back to the top position of the record. This will ensure that *no* current will be passing through the electromagnetic circuit during the long intervals of *rest*. The other alternative is to disconnect the battery.

*Note* 3 : Find out results from the Necker's cube ; Reversed stair-cases, mother-daughter, or other ambiguous figures, and compare the various values as well as try to explain the differences, if any.

## EXPERIMENT 35

### PROBLEM

Find out the Extra Sensory Perception (*ESP*) ability of given *O*.

*Method and Statistical Technique:* Method of *card-guessing*. Statistics of probability.

### MATERIALS

A pack of *ESP* cards; battery and connecting wires; commutator; 2 spring press-keys for *E*; a single tap sound hammer; bulb-holder with bulb clamped on a retort stand; *O*'s signalling switch-board; Signal Box; *ESP* record-sheets.

(*i*) The pack of *ESP* cards (designed by Prof. Rhine) consists of 5 sets of 5 figures. The 5 figures are regular geometrical figures drawn in thick lines: they are a Square, a 5-pt Star, a Plus sign, a Circle, and a figure with 3 Wavy lines. These figures are assumed to be emotionally neutral. The lines are drawn in black, and are about ⅛″ thick. All the 5 sets are alike. Thus the pack of 25 cards contains 5 squares, 5 stars, 5 plus signs, and 5 waves.

(*ii*) The *single tap sound hammer* is controlled by an electro-magnet, operated by one *E*'s press-key, that makes the circuit. Thus any variation in the pressure interval by *E* does not affect the uniform single tap sound given by the hammer.

(*iii*) *O*'s signalling switch-board (designed by Prof. Jalota), consists of 8 switches; five for each of the 5 *ESP* card-figures, one Query (?) for correcting wrongly signalled responses to be revised by the following signal (*Revised*, or *second thought responses*). Of the rest, one signals the definitely *confident*, and the other the definitely *non-confident* guesses. Each *O*'s switch is connected through its corresponding signal-light (in the signal box), with the battery in a simple circuit made by *O*. The 8 switches of *O*, and the two keys of *E*, are connected by ten separate wires running parallel, with one pole of the battery, and by one common wire with the other pole of the battery: thus 11 wires are strung between the *E*'s table and *O*'s table. (The lines to the sound-hammer must be connected through the commutator on *E*'s table. It is more convenient to connect the battery poles directly through the commutator with all the circuits controlled by *O* and *E*.)

(*iv*) The *signal-box* (designed by Prof. Jalota) is a two-storeyed set of 8 small compartments, each with a bulb-holder and bulb. These 8 compartments bear the 5 symbols for the guessing of *ESP* cards (sq, ⊙, star, plus, wave), 1 query (?) and one red-glass compartment for not-confident, and 1 plain for confident guess signals.

PROCEDURE

(*i*) *E* shuffles the pack of *ESP* cards thoroughly 5 to 6 times. Then he places the pack *facing downwards* upon the table. He tests the apparatus and puts it in working order. *O* is seated on the Observer's table and *instructed* : "When you hear *two* taps in quick succession from the sound hammer ; kindly attend towards the figures on the screen before you, and bring your hands near to the signalling switch-board, and get ready to guess the cards. I will place *one* card on my table, and give you a single-tap signal. The image of some one figure will come relatively clearly to you. You press the switch with the corresponding symbol for about 1 second. In a couple of seconds, I will place the next card from the top of the pack, and you will again hear the tap. Once again, you will get an image, and again signal your guess. This guessing will continue until the pack is finished about which I will inform you by giving a signal with 3 quick-taps. Then you can have rest, till you again get the signal of 2 quick-taps, or the 'ready' signal."

"If I cannot follow your given signal, then I will switch on the *light beside the figures on the screen* ; and you should *repeat* the previous response."

"If you somehow press a *wrong* signal, or consider it proper to *revise* your guess ; you should at once press the *query* switch, and then immediately give the *correct* guess."

"When you feel *definitely confident* of your guess, you should also press the *confident* signal switch *immediately after* your guess-signal. But, when you feel *definitely not-confident* of a given guess, then you should press the *not-confident* signal switch immediately after the said response."

"If you do not like the experiment to continue, and you want to take a rest, etc., then you should press the query-signal switch 3 times in quick succession."

(It should be *clarified* to *O* that the *not-confident* signal is quite different from the single query-flash, which means that, the given guess is to be revised, and is being followed by the correct guess. While the *not-confident* signal merely indicates the *subjective quality* of the given guess, and does not imply any necessity for an immediate revision).

(*ii*) *Practice Experiment:* After instructions, *E* should take a number of *practice*-observations. First of all, *E* places a blank foolscap sheet on the table and puts the shuffled pack upon it face downwards. He marks one place on it for the *card-to-be-guessed*, and another for the *guessed-card* pile. (This will reduce the chance of soiling the *ESP* pack). Now *E* picks the top card from the pile of the pack (which is lying face downwards) and without attempting to see it, *E* places the said card still facing downwards on the place marked for card-to-be-guessed. *E* presses the key connected with the sound hammer; and he looks towards the signal-box for *O*'s guess response. He records the given guess in the *first* call-column, on the first *row* of the record-sheet. Then he removes that card (still facing downwards) to the place marked for guessed-cards. Now he picks up the new top card from the pack and places it facing downwards on the spot for the card-to-be-guessed, and he gives the tap-signal. He records the new guess in the 2nd row of the 1st call-column of the record-sheet; and he puts this card on the top of the earlier guessed-card (still facing downwards). In this way *E* continues, and as the pile of the shuffled pack-cards is being reduced, one by one, the pile of the guessed-cards goes on increasing in proportion. When the whole pack has been run through, *E* gives the *rest* signal by a set of 3 quick-taps. The commutator is reversed.

Now *E* picks the pile of the guessed-cards, inverts it, and places the pack on the blank paper beside the record-sheet. Now the top-card facing *E* is the one, that was the object of the 1st guess. So *E* records the symbol of that card in the first row of the first card-column, corresponding to the first call entry. He removes the said recorded card from the pile, and thus uncovers the card that was the object of the second guess. He notes the symbol for this card in the second row of the card-column adjacent to the second call-entry. In this way, *E* takes down all the card entries. Now, *E* again shuffles the pack 5–6 times; and continues the above procedure until he has obtained some 200 to 300 judgments (or guesses for 8 or 12 runs of the pack).

### Results

The raw results entered in the record sheet are, (*i*) analysed column-wise, and totalled for correct guesses as *direct hits* (*H*), *precognitions* (*P*), and *retrocognitions* (*R*). (This is done, although the instructions are for 'direct hits' only ; as there is a hypothesis that the peculiar sub-conscious inter-relation of *E* and *O* may favour one, and hinder another type of *ESP*-function. Hence, to be on the safe side, and also to give additional practice, we suggest analyses for obtaining all the three types of *H*, *P*, and *R* data.) The results are also (*ii*) analysed for correct guesses of the various figures.

In one case the results were tabulated as follows :

Table 12

COLUMN-WISE ANALYSIS (12 RUNS)

| *Col.* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *H* | 8 | 2 | 2 | 5 | 5 | 8 | 9 | 5 | 5 | 7 | 3 | 5 | 64 |
| *P* | 3 | 6 | 6 | 7 | 3 | 4 | 1 | 6 | 4 | 3 | 4 | 4 | 51 |
| *R* | 2 | 6 | 5 | 5 | 5 | 3 | 2 | 6 | 1 | 2 | 8 | 3 | 48 |

(Data of M. Sood.)

Table 13

FIGURE-WISE GUESSES

| $S_v$ | *H* | *P* | *R* |
|---|---|---|---|
| *Sq* | 19 | 10 | 7 |
| + | 7 | 6 | 6 |
| ⊙ | 15 | 16 | 17 |
| * | 8 | 5 | 6 |
| *W* | 15 | 14 | 12 |
| Total | 64 | 51 | 48 |

TABLE 14

GIVING CALLS FOR FIGURES

| | *Calls* | *sq* | ⊙ | + | * | *w* | *Total* |
|---|---|---|---|---|---|---|---|
| ← Cards $S_v$ → | Square | *16* | 14 | 4 | 9 | 17 | 60 |
| | Circle | 12 | *22* | 5 | 6 | 15 | 60 |
| | Plus | 6 | 22 | *10* | 8 | 14 | 60 |
| | Star | 13 | 13 | 7 | *12* | 15 | 60 |
| | Waves | 11 | 13 | 8 | 7 | *21* | 60 |
| | Total | 58 | 84 | 34 | 42 | 82 | 300 |

(Data of S. Bhaduri.)

A still more meaningful analysis requires the tabulation of the call-data for each of the stimulus-figures, as in *Table* 14. Here, the *row-total* acts as a check upon our analysis. While the *column-total* shows the subjective bias of the *O*. The *main diagonal cells* indicate the direct-hit correct guess score per figure. The other cells indicate the quantities of the *confusions* between the card and its calls.

*Table* 12, can also be used to indicate fluctuations of *H*, *P* and *R* functions of *ESP* during the progress of the experiment, by drawing 3 curves on one graph.

*Table* 13, can be transformed into *bar-charts* for *each figure* (or $S_v$), and illustrate the bias for a given *ESP*-function (*H*, *P* or *R*) by *O*.

*Table* 14, provides detailed data for elaborate comparisons, by keeping in view the varying bias of *O* for certain calls, and qualifying his success in scoring hits for the given figures.

*Calculations :* Since we have 5 sets of 5 figures each, the probability in favour of a correct guess by mere *chance* is 1/5 (or $p$); and the probability against it is 4/5 (or $q$). If $N$ be the number of observations in one set (*i.e.* 25); then the *SD* would be found by the formula: $SD = \sqrt{Npq}$. If $N = 100$; then the number of *chance* guesses is $N/5 = m = 20$.

When correct guesses are more than chance, then the score is *encouraging*, upto $m + 2SD$ (*i.e.* $20 + 2 \times \sqrt{100 \times 1/5 \times 4/5}$

$= 20 + 2 \times 4 = 28$). If the score is still higher, it is described as *good* upto $m + 3SD$ (*i.e.* 32). All higher results are classed as *very good* (*i.e.* 33 and above).

The following chart is useful to determine the *ESP*-ability in the case of multiples of 100 guesses :

| *Runs of the pack* | *Chance* | *Encouraging* | *Good* | *Very Good* |
|---|---|---|---|---|
| 4 | 20 | 21 — 28 | 29 — 32 | 33 — 100 |
| 8 | 40 | 41 — 52 | 53 — 57 | 58 — 200 |
| 12 | 60 | 61 — 74 | 75 — 81 | 82 — 300 |
| 16 | 80 | 81 — 97 | 98 — 104 | 105 — 400 |

*Note* 1 : If the signal to guess the top-card of the pack is given, before the card is taken from the pack and removed to its mark on the sheet ; then there is a hypothetical objection regarding the possibility of confusion of the said top-card figure, with other figures on the cards beneath it in the pack (or pile). Thus the experimental condition will become more complex than necessary.

*Note* 2 : Persons with a belief in the genuineness of the *ESP*-ability are known to obtain better scores than the unbelieving or suspicious observers.

*Note* 3 : When we use only *one* pack of 25 cards, *statistical stringency* will not admit the accuracy of the figures given in the chart for 100 (or multiple) guesses. They will insist upon the pooling and joint shuffling of 4 packs of 25 ; that is the use of a set of 100 cards for the guessing experiment. Otherwise they will suggest, that for 4 sets of guesses with a pack of 25 cards ; the chance score is $4 \times 5 = 20$ ; and since $SD$ for 25 guesses is $\sqrt{25 \times 1/5 \times 4/5} = 2$ ; hence $2SD$ for 4 runs of one pack $= 4(2 \times 2) = 16$ ; and in the same way $3SD = 4(3 \times 2) = 24$. In other words, the *encouraging* score ranges upto 36 ; and *good* upto 44.

*Note :* The *ESP*-function is also known as Psi-function (or $\Psi$).

## EXPERIMENT 36

### PROBLEM

Determine the telepathy-ability of a given $O$.

*Method and Statistical Technique:* Significance of probability differences; correlation (Pearson's *product-moment* $r$ from small samples).

### MATERIALS

Same as in Experiment 35.

### PROCEDURE

(*i*) The preliminary procedures and instructions are the same as in Experiment 35.

(*ii*) $E$ picks the top-card from the shuffled pack placed on the sheet facing downwards; and places that card *facing upwards* on the card-guessing mark. *E looks at the card* and also gives the tap-signal. He records the guess in the call column, and also records the card in the card column on the first row of the first set of recording columns. Now, $E$ puts the guessed card facing downwards on the guessed-card mark. $E$ picks up the new top-card of the pack, places it facing upwards on the card-to-be-guessed mark, looks at the said figure and also gives the signal to guess. He records the guess, as well as the card, in the second row of the card and call columns on the record sheet. Again he picks the next card, and continues the earlier procedure, till he runs through the pack.

After reshuffling the pack thoroughly 5–6 times, $E$ continues through another run of the pack; and in this way takes about 300 guesses.

The results are analysed, tabulated, and the data given adequate statistical treatment. The data is also described in the form of bar-charts and other curves.

*Note* 1: Now that we know the Telepathy-ability of the same $O$ whom we have measured for *ESP*-functions; it would be interesting to compare these two functions, and determine the significance of the differences.

If there are 12 runs of the pack during the *ESP* experiment, then we have to obtain for (say *H*-function) the Mean Score and *SD* from the 12 figures available in the column-wise analysis. The $SE_M$ is obtained by the formula : $SE_M = \sigma / \sqrt{N}$, where *N* is the number of *runs* of the pack. $CR\sigma$ is calculated as $D/\sigma_{diff}$ ; and the $\sigma_{diff} = \sqrt{SE^2_{M1} + SE^2_{M2}}$.

In one case, we had the following data :

| | *N* | *M* | *SD* | $SE_M$ |
|---|---|---|---|---|
| *ESP* | 12 | 4.58 | 1.75 | .505 |
| Tele. | 12 | 4.83 | 1.46 | .426 |

Here, $\sigma_{diff} = .661$ ; hence $D/\sigma_{diff} = 0.25/.661 = 0.378$, insignificant.

*Note* 2 : Some workers prefer to use $PE = .6745\ SD$. The 'probability of occurrence' is estimated from $D/PE$. The *odds* against chance may be obtained from the following table giving odds (adapted from Fisher):

| $D/PE$ — | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Odds : 1— | 1 | 4.6 | 22 | 142 | 1300 | 20000 | 100000 |

*Note* 3 : We can find out the *correlation* between the *ESP* and the Telepathy abilities of *O*, by correlating the scores of the different columns of the record-sheet. A simple method with small samples is illustrated in the Table on next page.

For small samples, Pearson's Product-moment correlation is obtained as *r*, from the formula :

$$r_{XY} = \frac{N\Sigma XY - \Sigma X\, \Sigma Y}{\sqrt{\{N(\Sigma X^2) - (\Sigma X)^2\}\,\{N(\Sigma Y^2) - (\Sigma Y)^2\}}}$$

$$\therefore r_{ET} = \frac{12 \times 271 - 55 \times 58,}{\sqrt{\{1212 \times 289 - (55)^2\}\,\{12 \times 306 - (58)^2\}}}$$

|  | *ESP* |  | *Telepathy* |  |  |
|---|---|---|---|---|---|
| *Col* | $X$ | $X^2$ | $Y$ | $Y^2$ | $XY$ |
| 1 | 6 | 36 | 6 | 36 | 36 |
| 2 | 5 | 25 | 3 | 9 | 15 |
| 3 | 4 | 16 | 5 | 25 | 20 |
| 4 | 3 | 9 | 5 | 25 | 15 |
| 5 | 5 | 25 | 7 | 49 | 35 |
| 6 | 6 | 36 | 2 | 4 | 12 |
| 7 | 7 | 49 | 5 | 25 | 35 |
| 8 | 7 | 49 | 7 | 49 | 49 |
| 9 | 5 | 25 | 5 | 25 | 25 |
| 10 | 3 | 9 | 3 | 9 | 9 |
| 11 | 1 | 1 | 5 | 25 | 5 |
| 12 | 3 | 9 | 5 | 25 | 15 |
|  | 55 | 289 | 58 | 306 | 271 |

$$=\frac{3252-3190}{\sqrt{(3468-3025)\,(3672-3364)}}$$

$$=\frac{+\,62}{\sqrt{443\times 308}}=\frac{62}{369.4}=+\,.168 \text{ or } .17$$

The correlation of .17 nearly is both low and insignificant.

*Note* 4 : Now that we know the differences between $H$, $P$ and $R$ scores in the two conditions of *ESP* and Telepathy (for the same $O$); we may calculate the significance of the differences; and then comment upon our results.

*Note* 5 : An interesting modification of the Telepathy experiment is for $E$ to 'adopt an *active attitude*' while *transmitting* the figures seen by him to $O$. Thus we can see how far the active *facilitating* or the *inhibiting* attitudes are statistically significant.

*Note* 6 : The procedure may be slightly modified for a *stricter* comparison with the *ESP*-condition, by recording the telepathy responses like the *ESP* responses; *i.e.* At first only the 'call' is recorded, but the card is *not* to be also recorded at the same time. Thus the *card*-order is to be entered in the record only after the whole pack has been run through. (We have suggested a less stringent procedure, which is more convenient). But *E* must note, that he is varying two conditions at the same time, (*i*) of seeing the card-to-be-guessed ; and (*ii*) of knowing the success or failure of *O*'s guesses.

*Note* 7 : The standard Error of a correlation can be found by the formula : $SE_r = \sigma_r = \dfrac{1 - r^2}{\sqrt{N - 1}}$

$PE_r = .67449 SE_r$ or $.675\sigma_r$.

# EXPERIMENT 37

### PROBLEM

To find out the *progress in learning* to perform a task by 'trial and error' (Learning by doing).

### MATERIALS

Three electrical point maze-boards (designed by Prof. Jalota); a red and white light signal box; maze stylus; a sound hammer; a mild shock inductorium; retort stands with clamp cross-heads; battery and connecting wires; 3 designs of mazes; response record-sheets; screen.

(*i*) The *electrical point-maze** consists of 20 rows and 20 columns of metal points. Some of them are connected by *E* to form a maze-path. Parallel with these points, *E* connects other points by two sets of *guide-lines*. Any contact of the stylus with a point on the maze-path gives the white (or yellow) light, the *right*, or GO ON signal; but any contact with the points away from the path, that is points on the guide-lines gives the *wrong* or GO BACK signal, which may be a red light in the signal box (or a sound signal, or an electric shock).

(*ii*) The *stylus* is a ½″ thick rod with a small metal point. It is connected by means of a two feet flexible wire to a point on the board.

(*iii*) The *maze-path circuit* is connected in series with the white light (or any other) *right*-signal; and the *guide-lines circuit* is in series with the wrong signal (red light, or sound, or shock, etc.).

(When the inductorium is used, it is more convenient to have it operated by a separate battery, or accumulator, and tap only the induction shocks through the guide-line circuits.)

### PROCEDURE

*E* prepares 3 designs of mazes: (*i*) A *simple* progressive maze with alleys on the right and left. (*ii*) A *complex* maze; and (*iii*) a complex maze comparable with (*ii*), but with 2 or more *blind alleys* (*one* near the beginning, and *one* near the end, are the minimum).

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*Reported in *Ind. J. Psychol.*, 1954, pp. 181-84.

*E* arranges one maze-path and appropriate caution or guide-lines on each board. On each board, the initial point on the path is indicated by a chalk mark.

*E* presents design-1 to *O*. He demonstrates that the contact of the stylus on the chalk-mark gives a flash of white light in the signal-box, and its contact with one of the adjacent points alone gives the right or *go on* signal ; but any contact with other adjacent points gives the wrong, or *go back* signal.

*Instruction :* "Place the stylus on the chalk-mark near you ; it will give the white light, (or go on) signal. Now touch any of the adjacent points on the right or left, in front or behind ; if there is *white light or GO ON signal*, you are on the right path, and you should try again for a contact with an adjacent point *R* or *L*, *F* or *B*. But, if the new point-contact give the *red or GO BACK signal*, then you are *not* on the maze path, and the response should be revised by *going back to the earlier point where you were* (or whence you started on this move). Continue in this way, until you hear the bell (or buzzer) signal."

*E* will keep a record of time and responses.

*E* will give *O* rest for 30 to 60 seconds. Take a fresh record-sheet, and ask *O* to try again. Design -1 will be attempted again, until *O* is able to perform the task in 30″ (or with only two errors).

Now *E* presents design-2 to *O*, and takes the record of his performance. After design-2 has been learnt to a satisfactory standard, then *E* presents design-3. (If desired, an interesting variation would be the alteration of the caution signal to a sound or shock).

## RESULTS

Draw curves of learning for time, and for errors. Comment upon the peculiarities of the different *runs* through the maze. Special consideration should be given to the relative difficulties of the blind-alleys ; and the influence of various caution signals, etc.

*Note* 1 : Experiments about *transfer of training* can be obtained (*a*) by giving 5 practice runs through the 2nd maze, and (*b*) by giving 10 runs (or so) through the 2nd maze ; (*c*) by giving *no* practice ; to different groups of observers.

*Note* 2: An experiment with a mirror-drawing task can also serve to give a good *time curve*. The experiment on the *transfer of training* may be designed by giving 2, 4, and 6 trials with a 5-pt star, and then obtaining 8 to 10 records with a 6-pt star, from different groups of observers.

## EXPERIMENT 38

### PROBLEM

To find out the progress in conditioning of a motor response.
*Method :* Method of *partial conditioning.*

### MATERIALS

Conditioning-board ; batteries and connecting wires ; a mild shock inductorium ; Kymograph ; one electromagnetic stylus for time signal ; one electromagnetic stylus for bell ; tambour with a length of connecting tubing ; timing unit ; blind goggles.

(*i*) The *conditioning-board* consists of a wooden board with a metal plate, on which is placed the palm of *O*. The protruding middle-finger is put in contact with an adjustable metal bar. On the board there is also an adjustable height inverted tambour, with a metal curved finger-rest attached to the tambour-diaphragm. The latter is placed in contact with the dorsal side of the middle finger ; so that each slight movement of the said finger can be transferred to a recording tambour, that is in contact with the kymograph.

(*ii*) The mild-shock *inductorium* is designed to give a series of induction shocks, which are transmitted through a key-controlled circuit to the conditioning board.

(*iii*) Time marking for relatively longer intervals of 1″ is obtained by means of a *timing-unit* controlling the contacts of an electromagnetic stylus ; or some other apparatus.

### PROCEDURE

*E* asks *O* to place his palm upon the metal plate of the conditioning board ; and then adjusts the apparatus. *E* gives a couple of mild shocks to determine the shock-intensity suitable for *O*. The kymograph is arranged to carry records for (*i*) time-marking in 1″ units, (*ii*) Electric shocks, (*iii*) finger response, and (*iv*) bell stimulus. All these indicators should be marking at different levels, but as far as possible they should be in a single vertical line (*vide*, figure in Jalota's *Text Book of Psychology*, 1952, p. 298).

*E* gives a couple of bell-signals alone (at 3 to 4″ each). Then he gives a number of (4 to 5) Shock + Bell stimuli, at some 4″ intervals.

Now *E* gives the bell alone, just for once. If there is no-response, or only a *mild* response ; then *E* gives a further series of conditioning shocks + bell stimuli (4 to 6). The number of these conditioning shocks should be varied from one series to another. When the *conditioned-response* is of standard strength, *i.e.* it is as distinct and high as the response to the conditioning stimulus ; then a last reinforcing series of bell + shock is given ; and then the *bell alone* is repeated every four seconds. These responses are 'conditioned responses'. A set of three successive conditioned-responses, is taken as a laboratory criterion to indicate the establishing of a *partial* conditioned response.

A further reinforcing conditioning series may be followed by the bell-alone series, until the said conditioned response disappears (or is greatly reduced).

RESULTS

The kymogram data is tabulated as follows :

| *Ser. No.* | *Stimulus* | *Response* | *Remarks* |
|---|---|---|---|
| 1 | Shock | yes | natural reflex |
| 2 | *S* | " | " |
| 3 | Bell | No | |
| 4 | *B* | " | |
| 5 | *S* + *B* | yes | Cond'g Ser-1 |
| . | . . | . | . . |
| *n* | *B* | yes | Cond'd Resp. |

The data is converted into a graph, indicating the character of the *C-R* after each series of conditioning stimuli. The length of the responses after each series of conditioning may be quantified as 0, 1, 2 to indicate 'No, partial, or complete response movements' respectively.

The number of conditioned responses leading to 'extinction' should be noted. (*Vide, Ind. J. Psychology*, 1931, p. 111).

*Note* 1 : *O* may be instructed to *facilitate*, or to *inhibit* the formation of partial conditioning.

*Note* 2 : *O* may be asked to keep *busy* reading a book, or a story, while the conditioning is being established.

## EXPERIMENT 39

### PROBLEM

To determine the *norms* for a given individual test (Koh's Block Design).

*Method and Statistical Technique :* Techniques of test standardization.

### MATERIALS

A box of Koh's blocks and a set of designs ; stop-watch ; manual of directions, record sheets (a minimum of 16 testees).

(*i*) The Koh's blocks are wooden cubes of 1″ size. Of the 4 sides of each cube, one is painted White, one in Red, one in Yellow and one in Blue. The top and the bottom are divided by a diagonal into two parts or triangles, each. One of the top-triangles is painted Red and the other White ; and the two bottom triangles are painted Yellow and Blue respectively.

(*ii*) The designs are in red-and-white, or in yellow-and-blue, or in mixtures of three or four of these colours. The designs are so prepared, that the Observer can combine the blocks and obtain a parallel design with the given wooden cubes.

Some simple designs are made by combining only four blocks. Two such simple designs are used for *demonstration* purposes. In one demonstration design, all blocks are used with single-colour sides (on top); but in the *second* demonstration design at least two triangular (or double coloured) sides of two blocks have to be used. Further, in the test proper some designs are to be completed by combining 4, 9 or 16 blocks. The set of block-design problems is assumed to be arranged in an ascending order of difficulty.

(*iii*) The time taken for completing each design, is measured by the stop-watch in seconds (fractions are rounded off).

### PROCEDURE

(*i*) Take two blocks, hold one in each hand, between the fore-finger and thumb, and let them present the same coloured side to the *testee*. Bring the two together saying, "Each of these blocks are of the same shape, and size," (turn them to show the 4 sides), "and they are all painted in the same way, (begin by presenting the one-coloured side, say) white on one side, and on others yellow, red and blue. (Now turn over the *top*, with two triangles). On one side, it is half-red and half-white, and (turn the bottom) on one side it is half-yellow and half-blue." Take another pair of cubes, and show their various sides to *T*. (In each case *care should be taken* that *the same sides are shown for both the presented cubes*). "Is it all clear ? Each cube is as good as another."

Now take Demonstration design-I : "Here is a simple design. We can make it with 4 blocks". (Now pick one cube, turn it slowly, and place its appropriate side facing upwards on the table. Now pick another, and slowly bring its proper side near the design, and then place the second block besides, the first, and say, "One white, one red, Good !" Now pick the third block, and turn its white side up, but *put it in the wrong* place. Again look at the design, and say, "No ! it is wrong, the white must be under the red (or above the red)" and put the third block in its proper place. Pick the fourth, turn the right side and continue turning to the *wrong* one, and correct yourself saying, "No ! it should be the red", and place the fourth block along with the rest. Press the 4 blocks together to form a compact set of the given design. Now take the design card, and place it alongside of the design, "yes, it is alright". Say, "now, you try it". Pick all the 4 cubes, and scatter them among the others by a twist and a flick of the fingers. When *T* has prepared the block-design : "Yes, it is quite right".

Now take Demonstration design-II : First prepare the part of the design obtained by combining full one-coloured sides. Now try to complete the rest of the design with the whole sides. "No ! No !" ; turn on the half-side, and then place it in the proper way. On picking the fourth block, say, "we want a half side". Turn the proper half-side up, but *place it in the wrong position ;* and then correct yourself. Now pick up the Demonstration-II card, and bring it near to the block-design, saying, "Red at bottom, yellow each corner ; blue triangle in the centre". Now ask *O* to prepare the Demonstration-II design after scattering the given 4 blocks. When *T* has finished : "I will give you these designs one by one. Some are prepared by 4 blocks ; others by 9, or by 16 blocks. I will tell you, when it is so. Now take this Design III, and prepare it with 4 blocks. Work as quickly as you can. O.K. ! Ready, Go !"

Start the stop-watch, without bringing it to the notice of *T*.

When *T* takes too much time, that is, continues working beyond the maximum time for the given design (without completing it); relieve him by saying, "Yes, it is rather complex, and takes a lot of time. Now you take some rest. Other designs are much more difficult, so we will leave them."

### RESULTS

The time for each design by each *T* is recorded as follows :

| | *Design I* | *II* | *III* | *IV* | *V* | *VI* | *VII* | *VIII* | *IX* | *X* |
|---|---|---|---|---|---|---|---|---|---|---|
| *T* No : | 1 | | | | | | | | | |
| | 2 | | | | | | | | | |
| | 3 | | | | | | | | | |
| | ... etc. | | | | | | | | | |

*Statistical treatment :* Arrange the *times taken for each design* in an ascending order. If the range is quite large, we can divide the times into 5 or 6 groups. But if the range is not large, we have to divide the said range of times into 3 or 4 intervals only. This can be done by following the proportions of the terms of a *binomial expansion ;* which provides us with the proportions for the intervals of a practically normal distribution. Thus, $(\frac{1}{2}+\frac{1}{2})^3 = \frac{1}{8}+\frac{3}{8}+\frac{3}{8}+\frac{1}{8}$. Hence, the fastest $\frac{1}{8}$th of the given group timings will be in the *A* category. The next $\frac{3}{8}$ of the group in the category *B ;* the next $\frac{3}{8}$ will be in the category *C ;* and all other slower testees will be placed in the category *D*. The maximum for *D*-category, will be the maximum time allowed for the given design. (Usually this figure is in minutes, or $\frac{1}{2}$ minutes). The next category *E* is the no-score class. Thus the *scores* for any design are tabulated thus :

TABLE 15

DESIGN IV

| *Category* | *Time* | *Score* |
|---|---|---|
| *A* | 1 — 25″ | 4 |
| *B* | 26 — 45″ | 3 |
| *C* | 46 — 90″ | 2 |
| *D* | 90 — 150″ | 1 |
| *E* | 151 + | 0 |

Prepare similar norms for each of the given designs. The performance of each $O$ is now scored for each design attempted by him, and the *total score* obtained. The total-scores of individuals are now classified in some 5 or so grades or categories.

*Note* 1 : When you deal with large numbers, the technique is much the same. However, it will become also necessary to note, whether the distribution of the timing-frequencies is more or less similar to the *normal* or probability curve, or not. If there are obvious differences, that is the distribution is *skewed*, one may modify the given design or problem, or the method of scoring ; or both. Proper procedures may be obtained from special texts. In large samples (50 +), one can attempt a percentile scale.

After score-norms have been prepared for each design, the total scores for the various testees should be calculated. These *total-scores* are again sub-divided into 4 categories, as in the case of the individual designs, or in a larger number of groups (with proportions from higher expansions), *e.g.* $(\frac{1}{2} + \frac{1}{2})^6$, which gives proportions out of a group of 64. The groups are, $1 + 6 + 15 + 20 + 15 + 6 + 1$. Thus we get 7 *scoring grades*. (The number of scoring grades is determined by the *range* and *distribution* of the total scores for a given group of $Ts$).

*Note* 2 : In the case of individual testing, $E$ should carefully note the *adjustments* of $O$ that may indicate characteristics of his personality. $E$ should note in the *preparatory* phase, the attitudes of diffidence, confidence, exaggerated speech, emotionality, nervousness, etc. Later, when $O$ meets with *difficulty*, $E$ should try to note $O$'s characteristic response to the wrong move, or to blocked *frustration*. Such observation, when carefully practised, proves of considerable use for *clinical psycho-diagnosis*. Hence, $E$ should be prepared to observe clinical psycho-diagnostic *indicators* (or pointers) during tests of individual performance.

(It is advised that at least *two* testees should be observed with a psycho-diagnostic point of view).

*Note* 3 : In one case, we got the following *credits for time* in seconds : and the *norms* for the given *grades* : (See Tables 16 and 17).

### TABLE 16

### NORMS

| Grade | Total Score |
|---|---|
| A | 25 + |
| B | 20 — 24 |
| C | 14 — 19 |
| D | 8 — 13 |
| E | 1 — 7 |

### TABLE 17

### BLOCK DESIGNS CREDITS FOR TIME TAKEN IN SECONDS

| Blocks | Design | Score 4 | *Credits for Time Taken in Seconds* | | | | Max |
|---|---|---|---|---|---|---|---|
| | | | *3* | *2* | *1* | *0* | |
| 4 | III | 1 — 15 | 16 — 33 | 34 — 60 | 61 — 150 | 151 + | $2\frac{1}{2}$ mts |
| 4 | IV | 1 — 25 | 26 — 45 | 46 — 90 | 91 — 150 | 151 + | $2\frac{1}{2}$ |
| 4 | V | 1 — 25 | 26 — 60 | 61 — 120 | 121 — 180 | 181 + | 3 |
| 9 | VI | 1 — 80 | 81 — 120 | 121 — 180 | 181 — 240 | 241 + | 4 |
| 9 | VII | 1 — 85 | 86 — 120 | 121 — 180 | 181 — 240 | 241 + | 4 |
| 16 | VIII | 1 — 110 | 111 — 180 | 181 — 210 | 211 — 300 | 301 + | 5 |
| 16 | IX | 1 — 155 | 156 — 200 | 201 — 230 | 231 — 300 | 301 + | 5 |
| 16 | X | 1 — 175 | 176 — 220 | 221 — 240 | 241 — 300 | 301 + | 5 |

## EXPERIMENT 40

### PROBLEM

To find out norms for the *Pass-along Test* and correlate scores with those on the *Block-design test.*

*Statistical Technique:* Method of correlation by *rank differences* (Spearman).

### MATERIALS

A box of the Pass-along test (Alexander) with designs and directions ; a stop-watch ; record-sheets.

### PROCEDURE

(*a*) *O* is seated comfortably, and Design-I is shown to him. *E* demonstrates how the pieces can be moved along in the free space of the wooden frame of the given design. The two lines at the top and bottom, one painted Red and the other Blue, are also shown, and the task is explained : "You have to slide the pieces anywhere that you can. You are *not to lift* the pieces. You have to try to bring the red piece in the same position, but near the red line, and to move along the blue pieces to the blue line." (The design is shown by *E* initially in the *reversed* position ; thus the red piece is near the blue line, and the blue pieces near the red line, and *O*'s task is to change it to the design given in the card before him).

*E* solves the demonstration set before *O ;* and then requests *O* to solve the same.

*E* takes Design-II, and instructs *O,* "Here is a new problem. You should *move* the pieces, *not lift* them ; and bring the red piece near the red-marked side, and move the blue pieces to the blue line. Work as quickly as you can."

*E* notes the time taken in seconds by means of a stop-watch.

When the Design-II is completed, and the time noted ; *E* takes the next design, places the pieces in the *initial* position, *i.e.* Red piece near the blue line, and blue pieces near the red line. *E* places the Design-III before *O,* saying, "Another design. A similar task. Do as quickly as you can."

The same procedure is followed with other designs, until *O* takes too much time ; *or* completes all the given designs.

The times for each design are arranged in an ascending order, and then put into scoring categories. The performance of each *O* is then scored for each design, and the total scores obtained. The total scores are also classified into 5 or 7 or more grades.

(*b*) When there are scores for the same individuals in two tests, then we can *correlate* the abilities measured by the given tests. Since, in a class practical batch the numbers are usually small (10–20); we arrange the scores in each test in a *descending order ;* and assign *ranks* to the scores from the highest to the lowest (or *vice versa*). Thus the best score obtains rank 1, and the lowest the last rank. When two or more individuals get the *same* score, they are given the *mean rank*, *e.g.* In *A*-test *H* and *I* occupy the positions 8 and 9 in the given rank order. Hence, their mean rank is $\frac{1}{2}(8 + 9) = 8.5$. (*Vide* Tables 18 and 19).

TABLE 18

| (*A*) *Ind* | *Score in A* | *Rank* |
|---|---|---|
| *A* | 83 | 1 |
| *B* | 77 | 2 |
| *C* | 73 | 3 |
| *D* | 67 | 4 |
| *E* | 66 | 5 |
| *F* | 64 | 6 |
| *G* | 58 | 7 |
| *H* | 40 | 8.5 |
| *I* | 40 | 8.5 |
| *J* | 12 | 10 |

TABLE 19

| (*B*) *Ind* | *Score in B* | *Rank* |
|---|---|---|
| *B* | 75 | 1 |
| *F* | 64 | 2 |
| *C* | 63 | 3 |
| *A* | 61 | 4 |
| *H* | 55 | 5 |
| *E* | 51 | 6 |
| *J* | 48 | 7.5 |
| *D* | 48 | 7.5 |
| *G* | 44 | 9 |
| *I* | 24 | 10 |

$$RHO_{AB} = \rho_{AB} = 1 - \frac{6\Sigma D^2}{n(n^2-1)} = 1 - \frac{6 \times 64}{10 \times 99} = \frac{990 - 384}{990} = +.61$$

$$\left[PE_\rho = 0.7063\, \frac{1-\rho^2}{\sqrt{n}}\right]$$

*Note* 1 *:* Some experimenters want *also* to get a score for *movements*. To obtain this score, *E* should use a Veeder's counter, and thus keep the record of *O*'s movements. However, as there is a very high correlation between the time taken and the movements employed, so others neglect the movement-score. In case norms for

TABLE 20

| (C) Ind | Rank in A | B | Diff (D) | $D^2$ |
|---|---|---|---|---|
| *A* | 1 | 4 | 3 | 9 |
| *B* | 2 | 1 | 1 | 1 |
| *C* | 3 | 3 | 0 | 0 |
| *D* | 4 | 7.5 | 3.5 | 12.25 |
| *E* | 5 | 6 | 1 | 1 |
| *F* | 6 | 2 | 4 | 16 |
| *G* | 7 | 9 | 2 | 4 |
| *H* | 8.5 | 5 | 3.5 | 12.25 |
| *I* | 8.5 | 10 | 1.5 | 2.25 |
| *J* | 10 | 7.5 | 2.5 | 6.25 |
| | | | $\Sigma D^2 =$ | 64.00 |

movements are desired, these are also to be obtained by the same technique as is used for time-norms.

*Note* 2: This test can also yield quite interesting psycho-diagnostic indications. *E* should observe and report at least two cases from the psycho-diagnostic point of view.

*Note* 3: In one case the following score grades (Table 21) and time credits (Table 22) were obtained:

TABLE 21

| *Grade* | *Score* |
|---|---|
| *A* | 21 + |
| *B* | 17 — 20 |
| *C* | 10 — 16 |
| *D* | 7 — 9 |
| *E* | 1 — 6 |

TABLE 22

| *Test* | *Credit for time in seconds* *3* | *2* | *1* | *0* | *Max. Time* |
|---|---|---|---|---|---|
| *III* | 1–15 | 16–20 | 21–30 | 31–60 | 1 mt |
| *IV* | 1–30 | 31–60 | 61–90 | 91–120 | 2 ,, |
| *V* | 1–45 | 46–60 | 61–90 | 91–120 | 2 ,, |
| *VI* | 1–45 | 46–90 | 91–100 | 101–180 | 3 ,, |
| *VII* | 1–60 | 61–100 | 101–120 | 121–180 | 3 ,, |
| *VIII* | 1–100 | 101–180 | 181–200 | 201–240 | 4 ,, |
| *IX* | 1–150 | 151–200 | 201–250 | 251–300 | 5 ,, |

(If possible, some similar work may also be done with other individual performance tests, *e.g.* Cube-construction, Dear-born Form-board, etc.).

## GROUP TESTS

INTRODUCTORY :

Psychological tests can be broadly classified as tests of *ability, aptitude, and attitudes* or personality and temperament. All types of tests are prepared for testing, either one individual or a group of individuals at a time. The *group tests* enable us to test a large number of individuals, in a relatively short period of time. Thus we can conveniently go in for large-scale testing. Statistics and norms, that are prepared from larger groups are definitely more *reliable, objective and scientific*, than the norms available in individual testing from small numbers. However, from the point of view of *clinical psycho-diagnosis*, the individual tests enjoy the advantage of careful and prolonged observation of the given testee under standard test conditions. It should be noted here, that each group-test can also be used to test one individual only, and thus provide adequate opportunity to an expert tester to note personality pointers. However individual tests do not escape from the charge of subjective bias. Such charges are often made by one school of testers against their rivals.

Most group-tests are of the pencil-and-paper variety. *Group tests* should be given by the *lecturer-in-charge* to the group of the practical class. He should observe the procedure given in the *Manual of Directions*. The *norms* given in the manual should be used with some *caution* ; as the psychology class practical group is rather a *selected sample*. After the test, the peculiar aspects of the instructions should be explained. The use of *Keys* by the students can be conveniently done with some reliability, if the answer-sheets of the students are inter-changed. However, *the results of the whole batch should be recorded by each student.*

## EXPERIMENT 41

PROBLEM

To determine the general mental ability (or intelligence) of the individuals in a given group by the verbal test in Hindi (*Sāmoohika Mānasika Yogyatā Parikshā* 4–51).

*Statistical Technique :* Use of *cumulative frequency ;* and derivation of *percentile scores, T-scores, and standard scores.*

MATERIALS

Re-usable Test Booklets ; answer-sheets ; manual of directions ; Key ; stop-watch. (Over and above the number of testees in the group, there should be *one* extra booklet and answer-sheet for *E*).

PROCEDURE

(*i*) The test booklets contain directions on the first page. These are read aloud verbatim by *E*. On the next page, there are examples : Half of them are solved, and they are explained by *E*. The other half are to be orally solved by *T*s. In case of any difficulty, the said example is solved once again, and explained in greater detail, with special reference to wrong or unsuitable alternatives. When all students have understood, they are given final instructions, and started on the *test proper*.

Information is given of 'half the time', and also when it is 5 minutes more.

(*ii*) After the test is over ; the booklets are collected along with the answer-sheets. The answer-sheets are distributed for marking. The results of all the individuals are written on the black-board ; but names need not be given, only initials will do.

(*iii*) Scores in sub-test abilities are obtained by the use of *element scoring keys*. If each element scoring key is distributed to one student, then seven of them would be busy ; and some others could assist them, and thus gain experience in scoring.

(At least 4 cases should be interpreted on the basis of their *profile* scores.)

RESULTS

The results are tabulated as follows :

| *Initial* | *Age Yrs* | *Score in Element* *1* | *2* | *3* | *4* | *5* | *6* | *7* | *Total* | *Mental age* | *I.Q. or.* percentile *position* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *A B* | 12 | 4 | 6 | 3 | 8 | 5 | 12 | 2 | 40 | 14–0 | |
| *C D* | | | | | | | | | | | |
| . . etc. | | | | | | | | | | | |

*Note* 1 : *Percentile scores* are found from the *actual distribution of scores* in the *standardization* sample. When the said distribution is fairly normal, then this can be made to yield convenient and reliable percentile norms. (Else the norms are open to some objections of selected sampling and proportionate unreliability.) The technique for obtaining percentile norms will be illustrated by the data for Total Scores on Test 4–51, from X Class students, $N = 706$.

| *Score Step Interval* | *f* | *Cumulative f* |
|---|---|---|
| 80 — 84 | 3 | 706 |
| 75 — 79 | 3 | 703 |
| 70 — 74 | 6 | 700 |
| 65 — 69 | 13 | 694 |
| 60 — 64 | 30 | 681 |
| 55 — 59 | 42 | 651 |
| 50 — 54 | 60 | 609 |
| 45 — 49 | 81 | 549 |
| 40 — 44 | 118 | 468 |
| 35 — 39 | 99 | 350 |
| 30 — 34 | 102 | 251 |
| 25 — 29 | 66 | 149 |
| 20 — 24 | 45 | 83 |
| 15 — 19 | 18 | 38 |
| 10 — 14 | 11 | 20 |
| 5 — 9 | 8 | 9 |
| 0 — 4 | 1 | 1 |

Data of S. Kulshreshtha.

The percentile figures are obtained for the 2, 5, 10, 20, 25, 30, 40, 50, 60, 70, 75, 80, 90, 95 and 98 percentile positions. (Some persons are easily satisfied with *decile* norms.)

When $N = 706$, we know that the 5 percentile person is $5 \times 706/100) = 35.3$rd or 36th person. Hence, the 5 percentile score is 19.

$$14 + \frac{36 - 20}{38 - 20} \times (19 - 14) = 14 + \frac{16}{18} \times 5 = 14 + \frac{40}{9} = 18.44$$

or 19 score.

In the same way, the 10 percentile persons is 70.6th or 71st. Hence we will have to interpolate to obtain the exact score (*vide* Experiment 26).

$$10 \text{ percentile score} = 19 + \frac{71 - 38}{83 - 38} \times (24 - 19) = 22.7 \text{ or } 23.$$

(The decimal fraction in this case is *always* rounded off to the *next* higher figure; as we have actually no fractional scores or individuals. But this involves a slight error, which should be kept in view.)

*Note* 2 : *Standard Scores* (*SS*) or *Z*-scores are obtained as *positive*, or *negative* "deviation from the Mean" scores, in terms of *SD*-units. Thus Z-score $= (X - M)/\sigma$.

*Note* 3 : *T*-scores are parallel to the *Z*-scores, but the Mean is transformed into a standard figure of 50, and the *SD* is also transformed into 10. Thus all *T*-scores would have a Mean of 50, and *SD* of 10. It can be obtained by the formula : *T*-score $= 50 + 10 \times$ *Z*-score.

(In some tests, Scale $= 5 \pm Z$; that is $M = 5$, and $SD = 1$.)

*Note* 4 : An Eleven-grade *C-Scale* is suggested, when the distribution of scores is fairly *normal* (or assumed to be so), and we know the Mean and *SD* figures. The range of the *middle* grade or Grade-5 is $M \pm .25SD$. The *higher* grades of 6, 7, 8, 9 and 10, are each of .5*SD* range *above* the 5th Grade. The *lower* grades of 4, 3, 2, 1 and 0, are also each of .5*SD* range *below* the 5th Grade.

Guilford has suggested a rejection of the extreme Grades of 0 and 10, being of little or no practical value. Thus he obtains the *Stanine Scale* of 9 Grades. (In such cases decimals upto .4 are *neglected*, and from .5 upwards are *rounded off* to the next higher number.)

## EXPERIMENT 42

### PROBLEM

To find out the general mental ability of the individuals in a given group by the group verbal test in English (20–52.)

*Statistical Technique:* Correlation from assumed mean, and scattergram charts.

### MATERIALS

Reusable test booklets; answer sheets (One booklet and one answer sheet extra for *E*); Manual of Directions; Scoring Key; stop-watch.

### PROCEDURE

As given in the *Manual of Directions.*

### RESULTS

Element scores are also obtained, and results tabulated as:

| *Initial* | *Age* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *Total Score* | *Percentile or C-scale Grade* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *A B* | | | | | | | | | | | | |
| *C D* | | | | | | | | | | | | |
| . . *etc.* | | | | | | | | | | | | |

*Note* 1: When the group is about 20, the procedure of correlation described in Experiment 36 is to be followed. But for larger groups of 30, or 40 persons, a somewhat modified technique will be found convenient. We *assume a mean* (*AM*) for each test, and calculate the *deviation from this mean* (*d*) score of the individuals, in the two tests ($d_1$ and $d_2$). Thus the task of calculating the product-moment is considerably simplified, as we have to deal with fairly small figures. We obtain $\Sigma d_1$; $\Sigma d_2$; $\Sigma d_1^2$, $\Sigma d_2^2$; $\Sigma d_1 . d_2$ scores. Due care should be taken to record whether the *sums of* $d_1$ and $d_2$, as well as of the product $d_1$, $d_2$ are positive or negative.

Corrections for the two variables ($c_1$, $c_2$) are found by the formula : (Actual Mean$_1$ — Assumed Mean$_1$)=$C_1$.

$c_1 = \frac{\Sigma\, d_1}{N}$; and $c_2 = \frac{\Sigma\, d_2}{N}$. Hence $SD_1 = \sqrt{\frac{\Sigma d^2_1}{N} - c_1^2}$; and $SD_2 = \sqrt{\frac{\Sigma d^2_2}{N} - c_2^2}$. Therefore $r_{12} = \frac{\Sigma d_1 . d_2 - N . c_1 . c_2}{N . SD_1 . SD_2}$

$$= \frac{\Sigma\, d_1 . d_2 - N . c_1 . c_2}{\sqrt{[\Sigma d^2_1 - N(c^2_1)]\, [\Sigma d^2_2 - N(c_2)^2]}}.$$

*Note* 2 : When we are dealing with data from quite large groups (60 to 100, or more persons); then it is useful to prepare a *correlation chart*, or *scattergram*. It is like a graph where the variables $X$ and $Y$, are treated as axes of $X$ and $Y$, with the *origin* at the assumed means (0, 0). Both the variables ($X$ and $Y$) are divided into convenient grouped-step units (or intervals). Thus the data for each individual can be located in some cell of the given scattergram. When $X$ is divided into 10 or 12 groups, and $Y$ is also divided into a similar number of groups, then by assuming the middle (or middling) group of each variable, *equal to zero*, we can give numerical weights to each deviation group as + 1, + 2, + 3, and — 1, — 2, — 3, etc. The analysis of the large correlation data into such a chart, simplifies the final calculations to a remarkable extent. We get the *frequency distribution* of $X$ by totalling the *columns* ($fx$); and that of $Y$ by totalling the *rows* ($fy$).

We obtain $\Sigma fxd$, $\Sigma fxd^2$, as well as $\Sigma fyd$, $\Sigma fyd^2$ ; and also $\Sigma fxd . fyd$.

$C'x = \frac{\Sigma fxd}{N}$ ; and $C'y = \frac{\Sigma fyd}{N}$ .Further $SD'x = \sigma'x = \sqrt{\frac{\Sigma fxd^2 C'x^2}{N}}$

and $SD'_y = \sigma'_y = \sqrt{\frac{\Sigma fyd^2 - C'^2_y}{N}}$.

Therefore $r_{xy} = \frac{\Sigma fxd . fyd - N . C'x . C'y}{N . \sigma'x . \sigma'y}$

If we also want to obtain Mean and $SD$ values ; then we have to convert the above grouped-step values by the following formulae :

$M_x = AMx + C'x \times i$; and $M_y = AMy + C'y \times i$

$SD_{dist \cdot x} = \sigma_x = i \times \sigma'_x$; and $SD_{dist \cdot y} = \sigma_y = i \times \sigma'_y$

(*AM* is taken to be the mid-point of the given interval).

*Note* 3: To illustrate the above, we take the data from 706 students of X Class, for the test-elements of *classification* and *analogies* (Data from S. K. Kulshreshtha, See *Scattergram* on p. 139). We get the following:

$$C'x = +175/706 = +.2478 \qquad C'y = -92/706 = -.1301$$

$$\sigma'_x = \sqrt{\frac{1615}{706} - .061} \qquad \sigma'y = \sqrt{\frac{3008}{706} - .017}$$

$$= \sqrt{2.286 - .061} \qquad = \sqrt{4.260 - .017}$$

$$\doteq \sqrt{2.225} = 1.492 \qquad = \sqrt{4.243} = 2.011$$

$$\text{Therefore } r_{xy} = \frac{+1276 - 706 \times .248\,(-.130)}{706 \times 1.492 \times 2.011}$$

$$= \frac{+1276 + 22.78}{2118.3} = \frac{+1298.78}{2118.3} = +.613$$

$$\text{And } Mx = 8.5 + 2 \times .25 \qquad My = 6.5 - 2 \times .13$$

$$= 9.00 \qquad = 6.24$$

$$SD_{dist \cdot x} = 2 \times 1.492 = 2.98 \qquad SD_{dist \cdot y} = 2 \times 2.011 = 4.02$$

*Note* 4: All the element-scores may be inter-correlated for a given group, and *G*-saturations may be calculated, or a factor-analysis attempted. (Appropriate texts of Spearman, Thurstone and Cattell should be consulted.)

For a reasonable reliability, however, such data should be obtained from 200 or more persons. But for the sake of practice in the technique only, one can attempt these statistical treatments with the class data.

Score in classification ($X$)

| | *Score* | 0–1 | 2–3 | 4–5 | 6–7 | 8–9 | 10–11 | 12–13 | 14–15 | 16–17 | *fy* | *d* | *fyd* | *fyd*² | *fyd.fxd** + | *fyd.fxd** — |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Score in analogies ($Y$) | 18–19 | | | | | | | | 2 | | 2 | +6 | 12 | 72 | 36 | |
| | 16–17 | | | | | | 1 | 3 | 6 | 1 | 11 | +5 | 55 | 275 | 145 | |
| | 14–15 | | | | | | 5 | 8 | 7 | 2 | 22 | +4 | 88 | 352 | 200 | |
| | 12–13 | | | | 1 | 4 | 19 | 22 | 7 | 2 | 55 | +3 | 165 | 495 | 276 | 3 |
| | 10–11 | | | 1 | 4 | 9 | 21 | 18 | 6 | | 59 | +2 | 118 | 236 | 150 | 12 |
| | 8–9 | | | 2 | 7 | 37 | 49 | 10 | 3 | | 108 | +1 | 108 | 108 | 78 | 11 |
| | 6–7 | | | 5 | 17 | 58 | 35 | 6 | 4 | | 125 | 0 | | | | |
| | 4–5 | | 3 | 9 | 29 | 33 | 26 | 6 | 3 | | 109 | —1 | —109 | 109 | 56 | 47 |
| | 2–3 | 5 | 9 | 16 | 29 | 31 | 19 | 5 | 1 | 1 | 116 | —2 | —232 | 464 | 216 | 72 |
| | 0–1 | 4 | 12 | 12 | 30 | 26 | 12 | 3 | | | 99 | —3 | —297 | 897 | 318 | 54 |
| | $\Sigma fx$ | 9 | 24 | 45 | 117 | 198 | 187 | 81 | 39 | 6 | 706 | | +546 | | +1475 | —199 |
| | *d* | — 4 | — 3 | — 2 | — 1 | 0 | + 1 | + 2 | + 3 | + 4 | | | —638 | | | |
| | $\Sigma fxd$ (+) | | | | | | +187 | +162 | +117 | +24 | + 490 | | | 3008 | +1276 | |
| | (—) | — 36 | — 72 | — 90 | —117 | | | | | | — 315 = +175 | | | | | |
| | $\Sigma fxd^2$ | 144 | 216 | 180 | 117 | | 187 | 324 | 351 | 96 | 1615 | | | | | |
| | $\Sigma fxd.fyd$(+) | + 88 | 171 | 154 | 177 | | +173 | 318 | 318 | 76 | +1475 | | | | | |
| | (—) | | | — 8 | — 8 | | —100 | — 5 | — 15 | — 8 | — 199 = +1276 | | | | | |

(*Check* : $\Sigma fxd.fyd = \Sigma fyd.fxd$). *fyd. fxd. are arranged in positive and negative columns.*

## EXPERIMENT 43

### PROBLEM

Find out the *adjustment score* of individuals in a group by using the inventory in Hindi 25–54.

### MATERIALS

Booklets of the inventory 25–54 (Vyaktitva parakh prashnāvali); Scoring Keys ; *T*-scale Norms.

### PROCEDURE

There is no definite time limit for personality inventories, but the testees are advised not to ponder over the problems, and to give their *first-response* by drawing a circle around one of the three alternatives, "yes ? No" (हां ? न), printed in front of each question or item. Thus *one* booklet is used up for the testing of each individual. When the Testee follows this instruction, then it takes him 30 to 40 minutes.

After the inventory is filled in ; the various adjustment scores are obtained with the aid of the several element-scoring keys. The total-score of each element is then converted into a *T*-score from the *T*-scale norms.

### RESULTS

The profile scores are drawn on a graph, and a *global* interpretation is attempted. When the score is *above* 70, or *below* 30, *i.e.* ± 2*SD*, it is specially commented upon. The report may run as follows : "Mr X Y Z, a young man of 20 years appears to be well-adjusted to the *home*, and has a very good adjustment to his *job*." "Mr A B C, a thin, undernourished man of 28, has an unstable adjustment ; having an excellent attitude towards his *job*, but only a poor adjustment to society. His anxiety about his *health* appears to hinder his *emotional* adjustment," etc.

*Note* 1 : A minimum of inventory scores of 4 persons should be interpreted by each *E*.

*Note* 2 ; For non-Hindi knowing testees, as well as for an interesting comparative study, one may also give the Bernreuter's inventory, and then compare the reports of individuals. Also correlate the scores of a group in the Hindi inventory with those in Bernreuter's inventory.

The scoring of the Bernreuter inventory can be greatly simplified by taking only ± 3, or higher scores, and counting them as ± 1; *e.g.* $+3$ or more $= +1$; $-2$ to $+2 = 0$; $-3$ or less $= -1$. (*Psy. Rev.*, 1954).

## EXPERIMENT 44

### PROBLEM

Find out the 16 basic personality attitudes of your subject by using the Revised 16-*PF* test in Hindi 35–56.

### MATERIALS

Reusable booklets ; answer sheets ; Manual of Directions and Norms ; Scoring Keys.

### PROCEDURE

There is no definite time-limit ; however, it should be answered in 40–50 minutes.

### RESULTS

Raw scores are converted into Standard Scores ; and profiles are drawn. The various factor scores are inter-related in the final global report upon the testee.

*Note* 1 : As some attitudes measured by this test are more or less similar to those measured by the adjustment inventory in Experiment 19 ; the element scores of a group of testees may be correlated from both experiments, and the correlation matrix commented upon.

Factor analysis may also be attempted, if desirable.

## EXPERIMENT 45

### PROBLEM

Find out the personality characteristics of the individuals (in a given group) from their responses to the *Thematic Apperception Test.*

### METHOD

*TAT* group projective technique.

### MATERIALS

A selected set of 7 *TAT* pictures ; one blank card ; stop-watch ; blank sheets for writing responses (stories); Bellak *TAT* analysis sheets; Manual of Directions ; stand (or screen) for exhibiting *TAT*-pictures.

### PROCEDURE

The Group is shown a *demonstration picture.* They are told, that here is an interesting test of your imagination, specially of creative imagination. In the picture, you see some persons. You have to imagine, *what* they are doing ; also what had led to the present situation ; and what is likely to be the outcome of the given episode. Well ! in this picture, what is going on ? Let us have a guess !" . . ."Good ! so (mention the suggestion) is happening now. "Why is it so ? What had occurred earlier ? Yes, another guess, please !" . . ."Good ! this (mention the given guess) had happened, and hence (mention first suggestion) is happening now. Well then what will be the consequences, the results of this situation ?". . . . . . "Oh yes, it may be so (mention third suggestion), or (mention fourth suggestion)". (If there is no fourth or fifth suggestion, then *E* should invent some probable outcomes, and mention them.)

You know any event with a beginning, a middle and an end is technically a *story.* So when you write what you imagine, you will be inventing a *story.* Sometimes *TAT* is called a 'story writing test'.

This test is very simple and interesting. I will give you half-a-minute to see and imagine about the picture. Do not start writing during this period ; but take full 30 seconds for your imagination to do your best. Then you will have 4 minutes to write. I will tell you when 3 minutes are over, or when only 1 minute is left, to finish writing your story."

"Do not write anything about this picture; it was meant only for demonstration. Now, kindly write on your answer-sheet, No. 1 (or Story No. 1). (Pause). All have written, No. 1. Now I will show you picture No. 1. (Place the picture on the stand, or expose the picture), and say aloud. "Half a minute to see and imagine." Measure ½ minute by the stop-watch, then remove the picture and say, "Now 4 minutes to write!" After 3 minutes, say, "Three minutes are over. One minute more to finish off your stories." Arrange the picture for the second story. When time is up, look round to see whether all have finished. Say, "time is up", but wait a few seconds longer (about 10″), if necessary, and then say, "Draw a line under the last line of your first story; and write No. 2 on the answer sheet. "Now see the picture for the next story." (Place the second picture and say), "Half a minute to see and imagine." After ½ minute, remove the picture saying, "Four minutes to write." After 3 minutes, "Three minutes are over, 1 minute more to finish off your stories." Arrange the picture for the next story. After time is up, say "Time is up." Look round to see that all have finished, and wait a few seconds, if necessary; and then say, "Draw a line under this story, and write the next number. Now, comes the next picture (Place the next picture and say) "Half a minute to see and imagine." Continue this procedure till you reach the *blank card*. Before exhibiting the blank card, say, "This time you will have to use more of your imagination. So far your task was to see a picture, and then imagine a story. This time, you imagine the picture, also. I will show you a *blank card*, kindly attend to the card, and imagine a picture as well as a story". . . Half a minute to look and imagine." After ½ minute, "Now 4 minutes to write."

(Some experimenters place the blank card last, as we suggest, but others want to show it earlier. In the latter case, after the blank card story, the usual procedure: "Draw a line under this story, and write the next number, etc."; and continue till the set is finished).

RESULTS

The stories written on the answer sheets are the *raw* data. Their analysis according to the Bellak Scheme, will help in clarifying the *common* aspects of the stories, and indicate the personality characteristics. An integrated report should be prepared for all the stories of an individual.

*Note* 1 : Each *theme* is to be understood as an interaction of an individual's *need* and the *press* of the social and physical environment. We should look for the *need-press* aspect, and thus we shall get a deeper understanding of the given testee, from the point of view of basic psycho-dynamics.

In each case of personality testing, there should be a more or less definite aim. Thus the interpretation will be possible from the given point of view, and it will prove of as much practical use, as it expresses the basic dynamics.

*Note* 2 : A psycho-analytic interpretation may also be suggested, if required by the given laboratory tradition.

*Note* 3 : To find Tetrachoric Correlation $= (r_t)$.

One Variable is dichotomised at the *median*.

If $a =$ Upper Half in *both* $X$ and $Y$ ;
$b =$ Upper Half in $X$, Lower Half in $Y$ ;
$c =$ Lower Half in $X$, Upper Half in $Y$ ;
$d =$ Lower Half in *both* $X$ and $Y$ ;

then $r_t = Cos \dfrac{180^\circ}{1 + \sqrt{\dfrac{ad}{bc}}}$

(*General Knowledge*)

| | | *Upper ½* | *Lower ½* | *Total* |
|---|---|---|---|---|
| English | Upper ½ | $a = 138$ | $b = 90$ | 228 |
| | Lower ½ | $c = 84$ | $d = 144$ | 228 |
| | Total | 222 | 234 | 456 |

Data from S. Kulshreshtha. ($ad = 19822$ ; $bc = 7560$)

$$\therefore r_t = Cos\left(\frac{180}{1 + \dfrac{140.968}{86.948}}\right) = Cos\left(\frac{180}{1 + 1.621}\right)$$

$$= Cos\left(\frac{180}{2.621}\right) = Cos\ 68.68^\circ = +.364.$$

## EXPERIMENT 46

### PROBLEM

To find out the *neurosis* score of the testee with the aid of group Rorschach technique (Eysenck's modification).

### METHOD

Group projective technique.

### MATERIALS

A set of Rorschach psycho-diagnostic plates ; group Rorschach answer sheets ; Scoring key.

### PROCEDURE

The Rorschach psycho-diagnostic plates are shown one-by-one to the group. Each *T* ranks the given responses, as being *most* like the exhibited ink-blot. The group takes 30–45 seconds on each plate. When the whole set is judged, then the responses are scored, and the neurosis-score of the individual is determined.

*Note* 1 *:* The scores may be correlated with other adjustment scores and attitude factors.

## EXPERIMENT 47

### PROBLEM

Find out the significance of some social attitudes with the aid of the *psycho-social questionnaire.*

*Statistical Technique:* The *CHI*-square criterion, and the coefficient of association.

### MATERIALS

Copies of the psycho-social questionnaire (2–50).

### PROCEDURE

The questionnaire usually consists of several items; each of which is concerned with some definite social attitude, and measures the same by the frequencies of choices from given alternatives in a specific social group, *e.g.* in one case, the item was:

Marriage is noble, because
(*a*) it is sanctified by God;
(*b*) it ensures continuation of the race;
(*c*) it can provide ideal companionship between men and women.

### RESULTS

The results to the different items are tabulated, as follows:

| *Alternatives* | *a* | *b* | *c* | *Total* |
|---|---|---|---|---|
| Observed frequency ($fo$) | 13 | 22 | 85 | 120 |
| Expected „ ($fe$) | 40 | 40 | 40 | 120 |
| $(fo-fe)$ | $-27$ | $-18$ | $+45$ | |
| $(fo-fe)^2$ | 729 | 324 | 2025 | |
| $(fo-fe)^2/fe$ | 18.23 | 8.10 | 50.63 | 76.96 |

Data of M. Saksena.

Responses of 120 persons to the item quoted above in 'procedure'.

Degrees of freedom $= df = 3 - 1 = 2$
$(CHI)^2 = \chi^2 = \Sigma\,[(fo - fe)^2/fe)] = 76.96$
We find from Chi-square tables, that for $2(df)$, the value significant at 0.01 level is 9.21 only. Thus we conclude, that the choices given above indicate *highly significant* trends : Young university students in the above group are indeed idealistic in their attitude towards marriage and romantic companionship.

*Note* 1 *:* Chi-square is a test to determine the significance of a difference in actual observation from *chance* expectation. It is used in a variety of psycho-physical problems also. But its use is most convenient in the evaluation of trends from questionnaires.

*Note* 2 *:* When any two items of a questionnaire have only *two* alternatives (or other alternatives can be reduced to 2), then we can find out a *coefficient of association* (Yule) between their responses by the formula :

$$Q = \frac{ad - bc}{ad + bc} \text{ or } \textit{Tetrachoric} \text{ Correlation} = r_t = Cos\,\frac{180}{1 + \sqrt{\dfrac{ad}{bc}}}$$

where,
$a$ = the number of cases in which *both* attributes are present,
$b$ = the number of cases in which 1st is *present* and 2nd is *absent*,
$c$ = the number of cases in which 2nd is *present* and 1st is *absent*,
$d$ = the number of cases in which both are absent.

In one case, items $a$ and $b$ were as follows :

(*a*) Do you think your friends with *inferior* economic status enjoy a *happy* married life ?

Yes, Mostly; Seldom, Never.

(*b*) Do you think persons with *superior* economic status are more likely to lead an *unhappy* married life ?

Yes, Mostly; Seldom, Never.

In the above two items, the *yes* and *mostly* answers were pooled together as *positive* (or Yes); and the *seldom* and *never* were pooled together as *negative* (or No). The results were :

| | *Item A*: | *Yes* | *No* |
|---|---|---|---|
| Item *B*: | Yes | 20 | 40 |
| | No | 32 | 28 |

$$\therefore Q = \frac{20 \times 28 - 40 \times 32}{20 \times 28 + 40 \times 32} = \frac{560 - 1280}{560 + 1280} = \frac{-720}{1840} = -\ .391.$$

So we conclude, that the responses to the two items are rather dissociated. The responses provoked by one are to a good extent the reverse of the other. In short, the form of the said items has a considerable influence upon the content of the answers by the given group.

*Note* 3*:* Tetrachoric Correlation for above data :

$$r_t = \mathit{Cos}\left(\frac{180^\circ}{1 + \sqrt{\dfrac{560}{1280}}}\right) = \mathit{Cos}\left(\frac{180^\circ}{1 + .6609}\right) = \mathit{Cos}\ 108.4^\circ$$

$$= \mathit{Cos}\ (180 - 108.4)^\circ = \mathit{Cos}\ 71.6^\circ = -\ .315.$$

## EXPERIMENT 48

### PROBLEM

To study the influence of primary group and of the public opinion upon an individual.

### MATERIALS

A couple of large sheets with irregular patterns of dots; stop-watch; paper strips for writing answers.

### PROCEDURE

*E* divides the group by lot into sub-groups of three students each, 2 members and 1 secretary. *E* calls each sub-group to the table, where the dot-sheets are to be exhibited. *E* exposes the dots for 30″ (a time too short to count but encourage guessing). After 30″, the sub-group is instructed: "Now go to your table. Each of you will write his first guess on page one, and then fold the same. Then the 2 members will discuss the number of dots seen by them. The secretary will only note the discussion, but *not* take part in it. After the discussion is over, each one of the group will write the second guess." (Discussion time is usually 5 minutes). [These instructions may be given to the various groups before starting to exhibit dots to individual sub-groups, if desired].

When all sub-groups have finished their discussions and written their second guesses. The entire group meets together. *E* collects the guesses of each sub-group, and writes them on the black-board:

| *Member & Sub-Group* | | *1st guess* | *2nd guess* | *(Space for 3rd guess)* |
|---|---|---|---|---|
| (1): | *A* | | | |
| | *B* | | | |
| (Sec) | *C* | | | |
| (2): | *D* | | | |
| | *E* | | | |
| | . . etc. | | | |

After all the first and second guesses are noted on the board; the answer-strips are returned to the individuals concerned. Now the secretaries of the sub-groups are asked to report the discussions. When all have finished, once again each student is asked to write a third guess. This is also collected and put upon the board. Typical variations are discussed in the class.

## EXPERIMENT 49

### PROBLEM

To find out the social structure of a group by means of a sociogram. *Statistical Technique :* Moreno's sociometric technique.

### MATERIALS

Sociability Questionnaire 32–55.

The sociability questionnaire consists of positive and negative questions regarding preferences for companions of the group for *food* and *play* activities. (It may be altered for 'work and food', or for 'work and play').

### PROCEDURE

*E* distributes the questionnaire, and instructs the students to write only the names of students in *that group*. Simple explanations may be given, if required : The persons, you *like most* to play with (or you *like least* to play with), are to be mentioned in your order of preference.

### RESULTS

The results of all the students of the group, for each question are to be put in the form of a *sociogram*. Each sociogram should be analysed for stars, triangles, pairs and isolates.

The results of a positive as well as a negative question about the same activity may be superposed in one sociogram, with the social relation lines in different colours. But this sometimes leads to considerable confusion. However, we have to compare the stars and isolates of the *positive sociogram* with the stars, etc. of the *negative sociogram.*

*Note* 1 *:* The results can also be tabulated as follows :

| *Ser. no.* | *Ind'l* | *Liked by* | *+ Soc'l value* | *Disliked by* | *— Soc'l value* |
|---|---|---|---|---|---|
| 1. | *A* | | | | |
| 2. | *B* | | | | |
| 3. | *C* | | | | |
| 4. | . . etc. | | | | |
| 5. | | | | | |

## *SUGGESTIONS FOR FURTHER STUDY*

TITCHENER, E. B., *Experimental Psychology ; Quantitative*, 1905.

KULPE, O., *Outlines of Psychology*, (Trans. by Titchener, E. B.), 1909, § 6, 7, 8.

ANDREWS, T. G., *Methods of Psychology*, 1948, Ch. 1 & 5.

PETERS, C. C., and VAN VOORHIS, *Statistical Procedures and Their Mathematica Bases*, 1940.

GUILFORD, J. P., *Fundamental Statistics in Psychology and Education*, 1956.

GUILFORD, J. P., *Psychometric Methods*, 1954.

WOODWORTH, R. S., and SCHLOSBERG, H., *Experimental Psychology*, 1955, Ch. 8 & 9.

EDWARDS, A. L., *Experimental Design in Psychological Research*, 1954, Chs. 1–12 & 17.

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[illegible]

Dr. Shyam Swarup Jalota (*b.* 1904) has had a brilliant academic career. He secured a first in Psychology (Honours) at the B.A. examination of the Punjab University and a double first at the M.A. examination of the Calcutta University from where he also secured his doctorate.

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